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Studying Mammals

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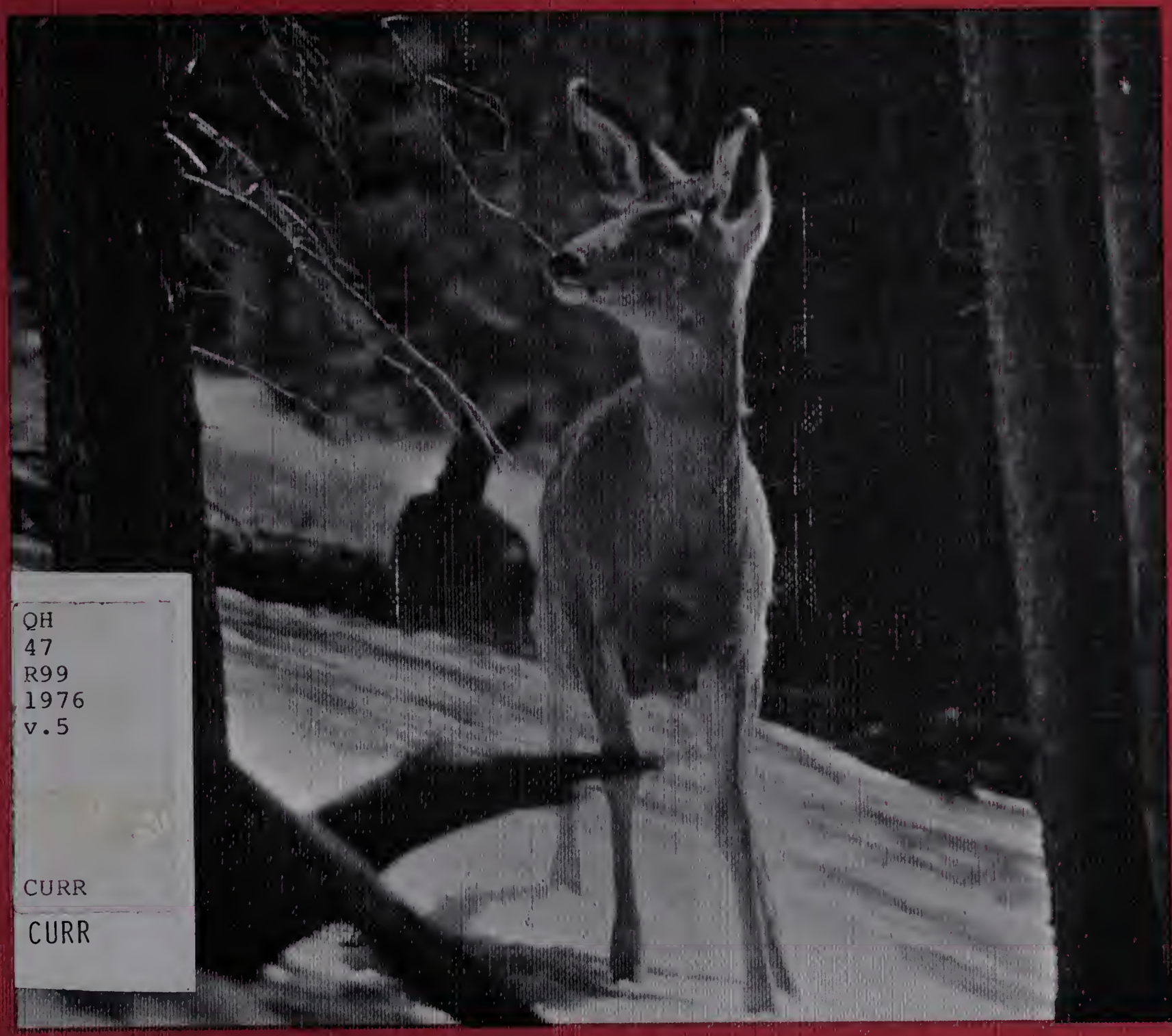
Blair Dawson / William Currie



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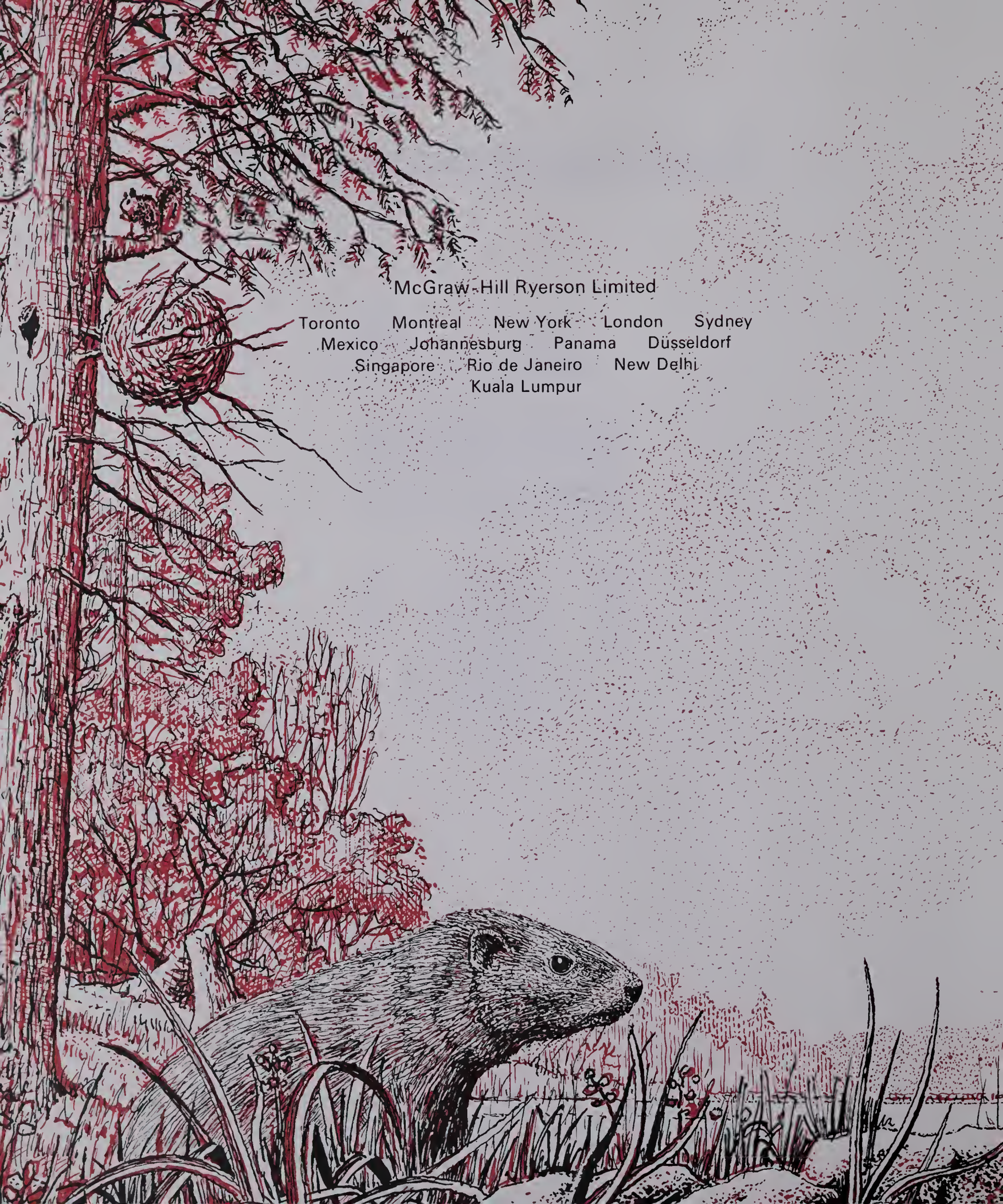
Studying Mammals



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Ryerson Science in Action

Studying Mammals

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Richard C. T. Gregory

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TO THE TEACHER

Children have a natural interest in animals; and, although studying them in or from the classroom is worthwhile, the very best way is get outside and observe them in their natural environment.

This book is oriented mainly to study in the out-of-doors. This type of teaching will be new to many, and some may hesitate to venture forth with this new and different teaching situation. *Don't* be dismayed! *Do* take the opportunity to observe, study, and learn along with your pupils. Let's go discovering!

Most of the suggested activities are simple, and a good many may be possible on or near your school grounds. Keep your first expedition as simple as possible. It will be helpful to visit your selected area before your class does, to map out your route and lay some plans. It is important to choose the best time and place for your first trip; some hints on this are found on pages 23 and 24.

In *Studies for Open Places* several methods of live-trapping mammals are outlined. If you bring wild animals back to the classroom, choose mice or moles, which are much easier to handle and care for than larger animals. In addition, most provincial game laws prohibit the trapping of larger wild animals except under the authority of a trapping or hunting licence. If live traps are being operated in cold weather, make sure there is sufficient insulation such as dried grass or leaves for the captured mammals. Shrews, which must eat constantly, are difficult to care for and are not recommended for classroom study. Hamsters and gerbils are perhaps the best classroom mammals. Chapter 5 has many ideas for mammal study in the classroom.

In spring, nature produces a bounty of young animals. Well-meaning humans sometimes find these appealing little creatures and mistakenly believe them to be orphans, although the mother usually is close at hand. It is the best policy by far to leave young animals alone. Rearing young wildlife in captivity is difficult, and if the animal lives it frequently becomes a burden. Freedom usually ends in tragedy; wild animals reared by humans are poorly armed for survival in the wild.

Studying Mammals was written to help students acquire the skills of scientific enquiry and further their appreciation of the animal world. As adults, their knowledge and attitudes will dictate the policies for the conservation and management of our natural resources.

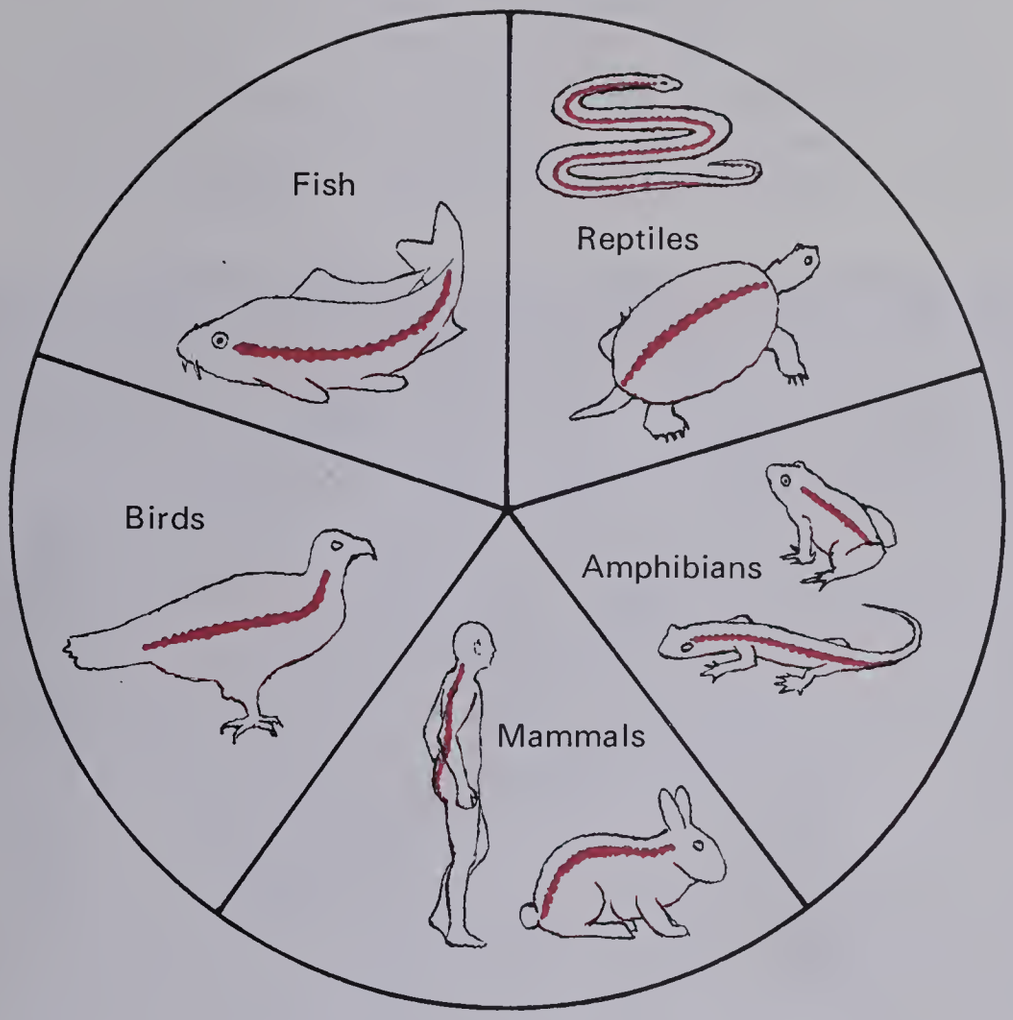
Those who have had an early introduction to nature study are fortunate indeed. May your lessons afield kindle an interest in the natural world leading to a lifetime of pleasure.

Chapter 1

MAMMALS ARE INTERESTING

Of all the many creatures in the world, the mammals have interested man more than any other. Mammals are the most successful group of animals on earth. Man is a mammal and so are many of the creatures he has brought close to him for food, clothing, transportation, and companionship. Even the rats and mice that live with him as unwelcome guests are mammals.

Scientists first divided the animal kingdom into two parts—*vertebrates* and *invertebrates*. Mammals belong to the group called vertebrates. All vertebrates have one thing in common. What is it?



Study the picture and discover what it is that vertebrates have in common.

The animal kingdom was then divided into a great many smaller groups. Animals with similar features or characteristics are grouped together.

What Are They Like?

Make a chart to show the special characteristics of mammals that you already know. It is easiest to sort out in your mind what *mammals* are like if you compare them with other things that are *not mammals*, such as birds, fish, or insects.

ALL MAMMALS PROVIDE MILK FOR THEIR YOUNG

Mammals are different from all other groups of animals because they alone produce milk to feed their young. Compare the care that mammals give to their offspring with the care given to young fish, reptiles, and birds. Which gives the longest care?

Only mammal mothers carry food for their young within their bodies. Why does this give mammals an advantage over other kinds of animals?

ONLY MAMMALS HAVE TRUE HAIR

Most mammals grow thick furry coats. Not all do, though. List several mammals that do not.

What happens to the hair coat of many mammals when the cold weather arrives? What happens when the weather turns warm again?

Some animals have various layers of hair—especially those animals whose fur is valuable for making into coats. Each of these layers serves a different purpose. Think of the beaver's habitat. How does his coat protect him? Find out how many layers are in his fur, and what purpose each layer serves.

During which season do trappers hunt for furs? Why?

Without their very thick coat of hair, these muskoxen would not be able to survive in Canada's arctic.

MAMMALS ARE INTELLIGENT

Mammals have the most *highly developed* brains of all the members of the animal kingdom. Their greater intelligence or brain power is probably the most important reason for their *superiority* over other animals.

What is meant by *superiority*? Why do we call man superior to all other animals? How does his greater brain power give him advantages?

The porpoise is among the most intelligent of wild mammals.

MAMMALS ARE WARMBLOODED

Another secret of the success of mammals is that they are *warmblooded*—that is, the heat of their bodies is maintained at an even temperature.

Birds also have this characteristic, but other groups of animals do not—for example, reptiles, fish, and amphibians.

Warmbloodedness gives mammals and birds a great advantage over these *coldblooded* creatures. Why? (Remember:

you are a mammal. What is the highest temperature in your part of the country? the lowest? What would happen to you in winter if your body did not keep itself at an even temperature?) Could the arctic fox or the polar bear survive if they were not warm-blooded? What happens to a snake or a frog when the temperature drops?

How is the dog helping to control his body heat? Can the boy do this in the same way? What is the normal body temperature of a human? What can cause this temperature to rise?

MAMMALS ARE ANIMALS WITH BACKBONES

In some ways, mammals are different from other animals with backbones. For instance, there are fewer bones making up the skull of a mammal. And nearly all mammals, no matter how long or how short their necks, have seven neckbones. Even the giraffe has only seven vertebrae in his neck.

This is the skeleton of a wolf. Can you count the vertebrae?

Count Your Neckbones

How many vertebrae can you feel in your own neck?

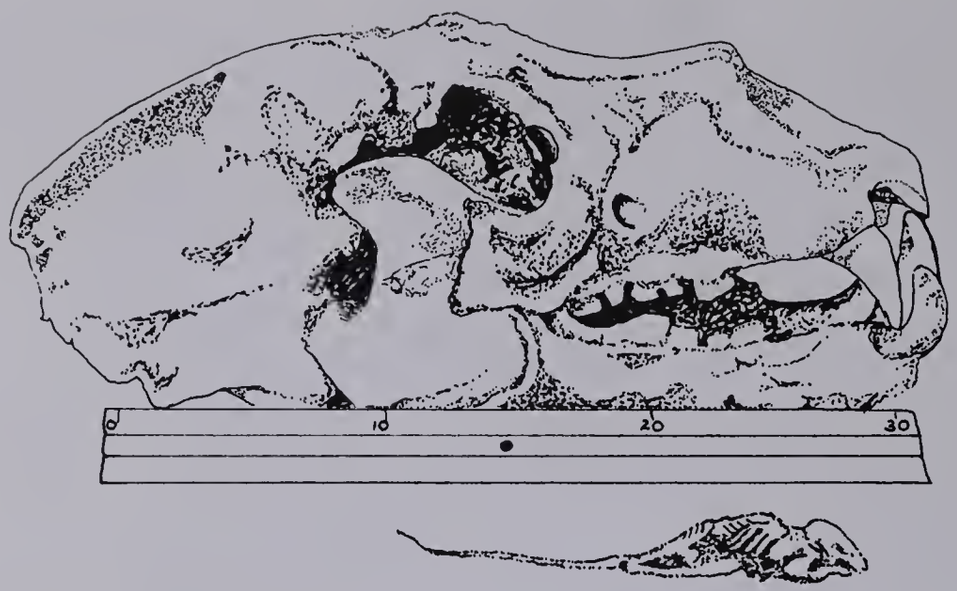
Try to imagine that your neck and back are made of one solid bone instead of several small vertebrae linked together. What would this do to your freedom of movement? Experiment to see how many ways your *vertebrate spine* lets you twist and bend your head and your body.

MAMMALS COME IN DIFFERENT SIZES

Mammals come in all shapes and sizes. The polar bear, which is the largest land mammal in Canada, can have a mass of almost a tonne. The tiny pygmy shrew, which is found in many parts of southern Canada, may not weigh more than a dime!

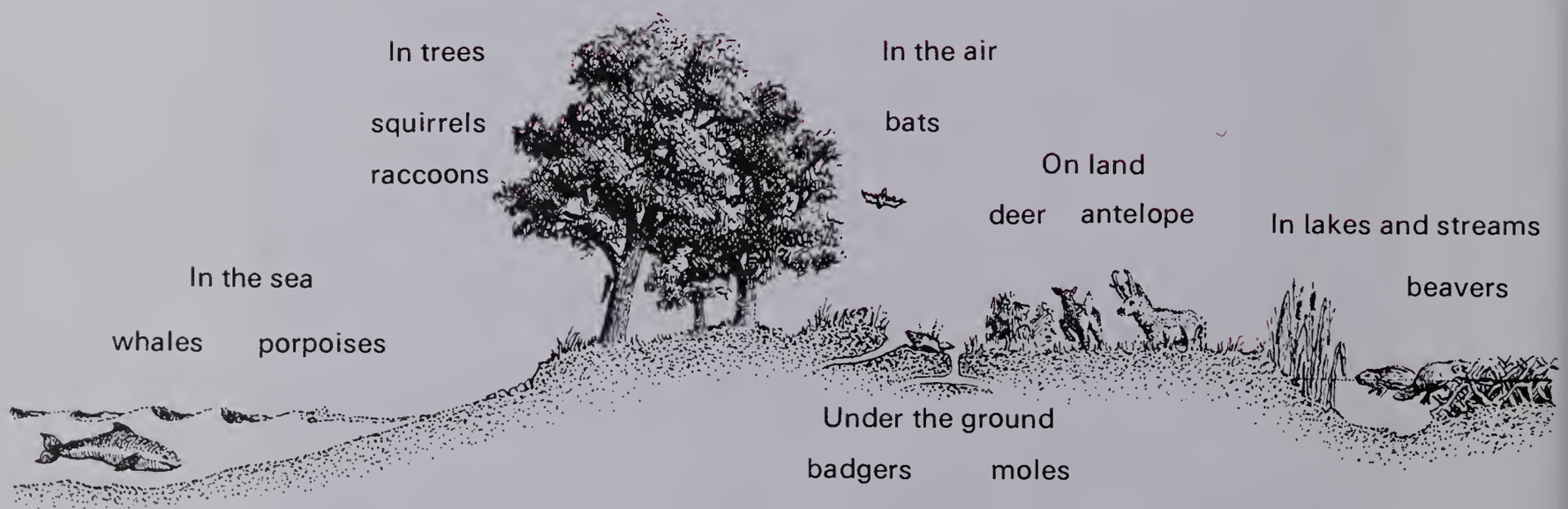
The polar bear is the largest Canadian land mammal. Does this make it the largest Canadian mammal? Why not?

The deer mouse is among the smallest of Canadian mammals.



Skull of a polar bear and skeleton of a deer mouse.

MAMMALS LIVE IN DIFFERENT HABITATS



Mammals live in many different places and under very different conditions. What other mammals live in the sea? Under the ground?

This western mammal is famous for his digging ability.

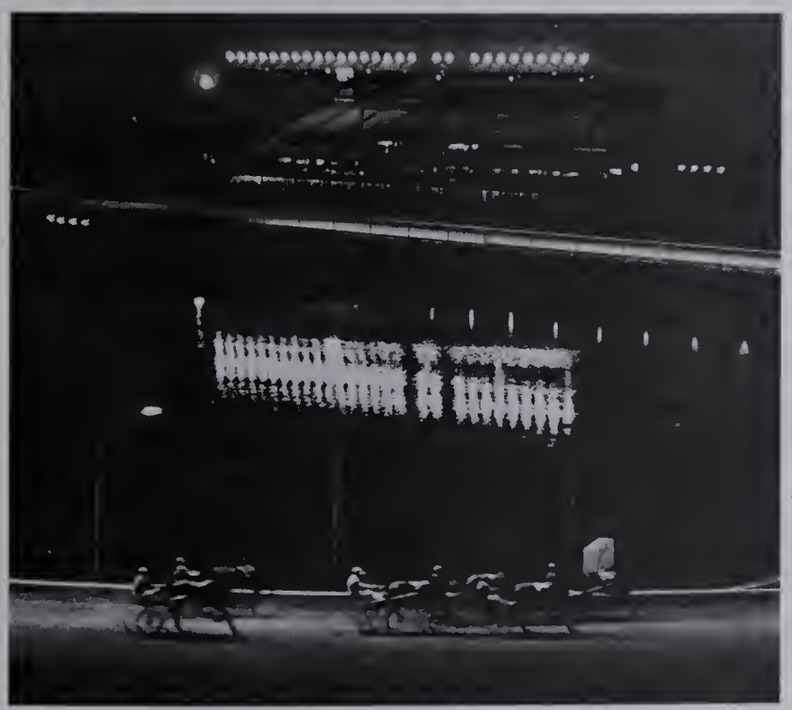
MAMMALS HAVE ALWAYS BEEN IMPORTANT TO MAN

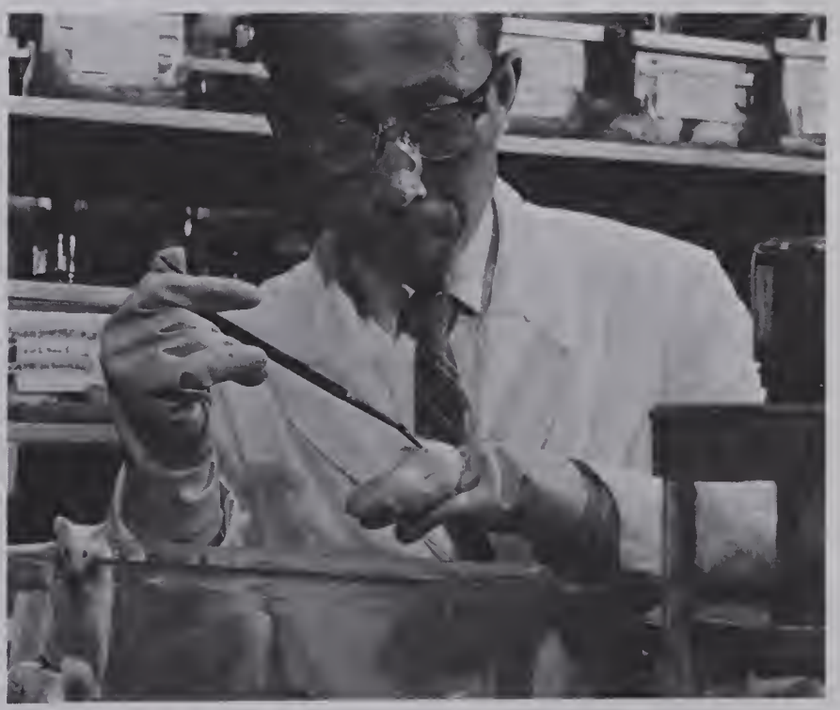
1. Which of the pictures on the following pages deal with exploration?
2. List as many mammals as you can that provide us with food. List those from which we get clothing.
3. Which mammals are used today for transportation? In what countries are they used?
4. Man has used mammals for many purposes:

   companionship
   medical discovery
   exploration
   hunting
   nature study

   What mammals can you list under each of these headings?
5. Why were buffalo very important to the Indians of the western plains?
6. In what ways are dogs useful to man? What kinds of dogs are used for each purpose? Are cats useful? Why?
7. Why did some pioneers use oxen rather than horses for farm work?

What is man's relationship to each of the mammals in the photographs?





Chapter 2

METHODS OF STUDY

Why study mammals? Perhaps we should consider this question before we think about *how* mammals may be studied.

In the first chapter, "Mammals Are Interesting", you learned how important mammals have been in providing man with a better life. Because of man's natural curiosity, he has studied the lives and behaviour of wild animals since very early times. This knowledge has given him food, clothing, transportation, and the ability to outsmart and use animals that are stronger and faster than he is.

As he learned more, man's control over wild animals increased and he tamed many for his use. Some of these animals have been domesticated for thousands of years. Over the years several of them have changed greatly in appearance, and they are still changing. What methods does man use to improve his domestic animals?

Wild mammals, the most difficult to study, have aroused our greatest curiosity. Today wildlife management is an important science, particularly since we have destroyed many of the homes or *habitats* of wild mammals. Can you list some ways in which we have done this?

The destruction of habitats such as forests, grasslands, and marshes is far more damaging to wildlife than hunting. With care, hunters can kill some of the animals nature produces each year without harm to future wildlife populations. Animals increase very rapidly if the proper conditions are present; if the conditions are destroyed, wildlife cannot survive.

Scientists can provide long lists of excellent reasons for studying mammals. But these reasons do not apply to the many people who study wild creatures for the enjoyment it provides. A famous mountain climber was once asked why he climbed the world's highest peaks. He answered, "Because they are there." This reason is quite good enough for mountains or mammals. It shows man's curiosity about the world around him. It is this natural curiosity, along with reasoning power, that has made

cottontail rabbit

man the most successful mammal on earth. Are there other reasons why man has been able to do better than other mammals?

SOME PEOPLE WHO STUDY MAMMALS

1. Agricultural scientists try to improve domestic livestock.
2. Doctors study laboratory animals to find cures for human sickness.
3. Wildlife scientists study untamed mammals. A large portion of the approximately 5 000 mammal species on earth live in the wild.
4. Amateur naturalists study mammals as a hobby.

HOW CAN I STUDY MAMMALS?

Mammals are more easily studied than you may think. Not only are domestic animals such as dogs and cats almost everywhere, but there are surprising numbers of wild animals, even in the city. Parks, wooded ravines, grassy vacant lots, and marshland bordering rivers, streams, and ponds are very good places to find mammals or their signs.

beaver

Fancy equipment or travel to faraway places is not necessary for animal study. Rather, you will need things like sharp ears and eyes, good powers of observation, and a pencil and notebook. A ruler for measuring tracks and plaster of paris for making casts are also useful. After reading this chapter and before going on a field trip, you can make a more complete list of useful equipment to take along.

Things To Consider

1. List the mammals you will expect to find in your area—in open grassy meadows, in woodlands, or along the banks of streams, rivers, lakes, ponds, or marshes.
2. Choose a study area and try to decide what will be the best possible conditions for observing and tracking animals.
3. Make a sketch map of your chosen study area to help you record the evidence of mammal activities that you will be collecting.

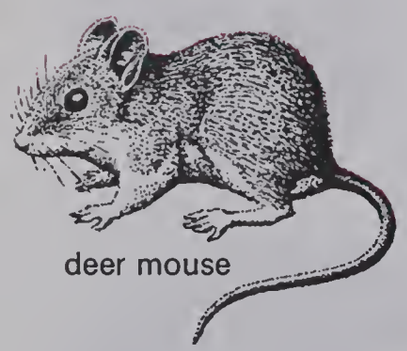
MAMMAL OBSERVATION

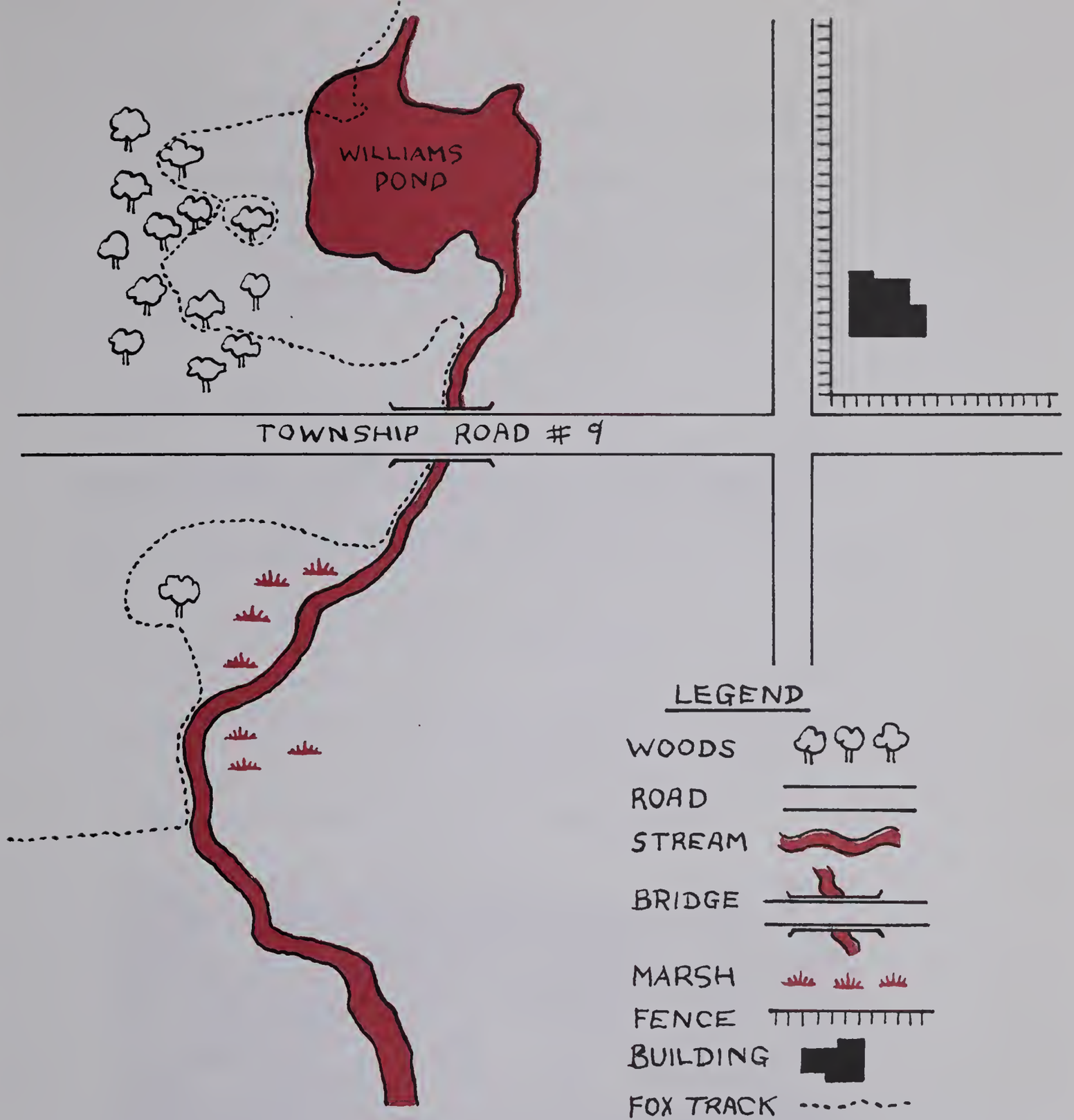
Many wild animals are in dens or are well hidden during daylight hours. Most are shy and clever at concealing themselves. Therefore it is difficult for even one person alone, moving slowly and carefully through the fields or forest, to get close to animals. With two or more people together, this becomes even harder. The careful observer, however, may see animals at any time.

Why are early morning and late evening the best times to observe animals? Why are squirrels, woodchucks, and ground squirrels (prairie gophers) so much easier to observe than most wild animals?

When observing, try to keep quiet and hidden. When wild animals know they are being watched, they usually stop whatever they are doing. Why?

Disturbed animals sometimes will go back to their normal activities if you keep hidden and still for quite a long time. Be patient.


deer mouse



SCALE 1 cm represents 10 cm

Your map can show the main landmarks, such as roads, fences, and marshes or streams. Then you can show where you found evidence of mammals right on the map. The map above shows the tracks of a fox. For mapping the activities of an animal with a smaller range, such as a rabbit or a squirrel, a map with a larger scale should be drawn.

As you watch the animals, try to find answers for these questions.

1. What are the animals doing? (Sleeping? Eating? Looking for food?)
2. Does your presence affect their behaviour in any way?
3. Does one animal affect the behaviour of another?
4. How do the animals move about? (Hopping? Running? Creeping?)
5. How do they eat their food?
6. What body features do they have that are especially suited to the food they eat?
7. Do animals play?
8. Are there "bullies" among them?
9. How do they protect themselves from danger?

BE A NATURE DETECTIVE

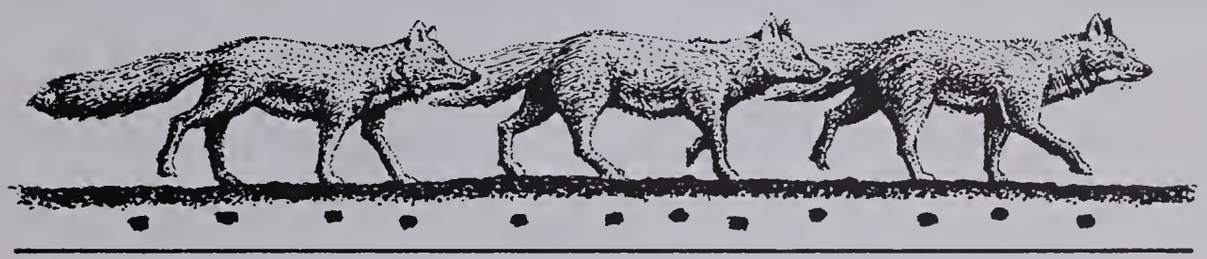
Tracks, hairs, and the droppings or scats of mammals are their "trademarks" and can help you identify mammals and what they have been doing. These clues may be all a nature detective has to work with to solve wildlife mysteries.

Tracks Are Important Clues

If you rake over a sandy area on your first visit, you will find good clear tracks in the sand when you come back.

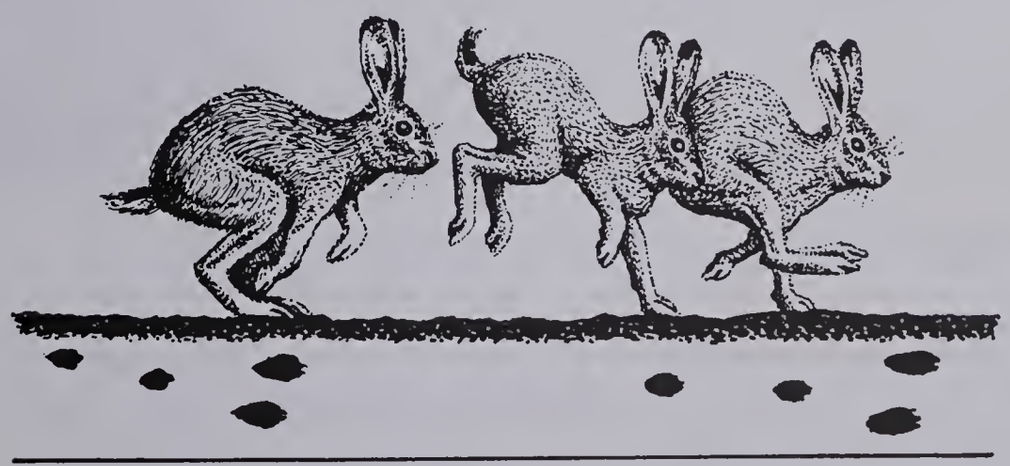
Four-footed mammals can be grouped into four different track types.

Some mammals leave single tracks, which generally form a zigzag line. Tracks of the hind feet often fall in the tracks of the fore feet. Tracks of the cat and the fox are "neater"; they fall almost in a straight line. Dogs, cats, foxes, wolves, deer, and horses walk like this.



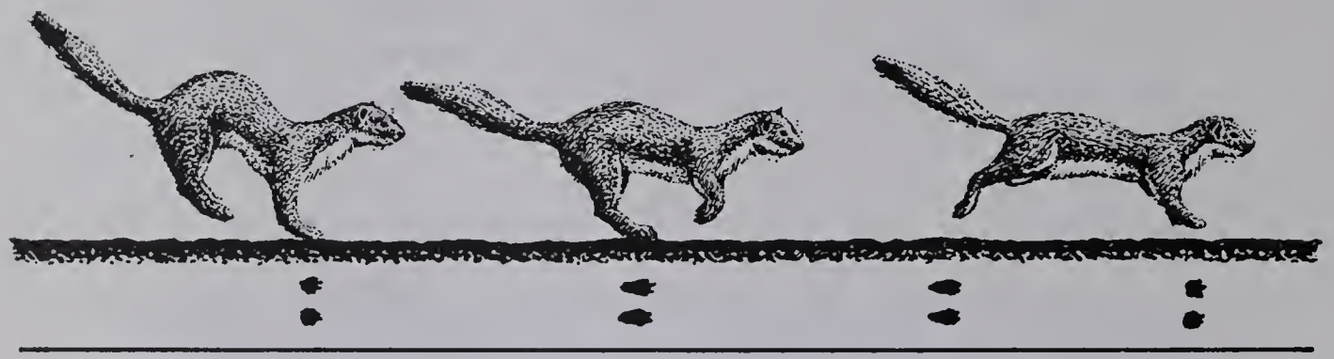
Typical gait of the fox. Only half the stride is shown.

Some mammals move in jumps, using the hind legs for power and the front legs for balance. Most of these animals have very long hind legs and short front ones. Rabbits, hares, squirrels, and jumping mice move like this.



Typical "gallop" of the hare

Some mammals gallop or run with a loping gait. The hind feet are usually placed right in the tracks of the fore feet. Most of these animals have long bodies and short legs. Otters, weasels, and mink gallop.



Typical "gallop" of the weasel

Some mammals, the "fatties", waddle. Their tracks are usually found in two lines with the steps close together. These animals have thick bodies and short legs. Skunks, porcupines, badgers, and bears are waddlers.

"Waddle" of the porcupine

Remember that perfect tracking conditions are rarely found and that tracks in deep snow or mud will be very different from those made on a harder surface. Why? Compare your own tracks in snow about 3 cm deep and snow about 30 cm deep.

It is easy to be fooled by tracks of animals of the same type. Many books show pictures of tracks smaller than they really are. After looking at tracks in a book, one student found a porcupine track in the snow and thought he had discovered a black bear!

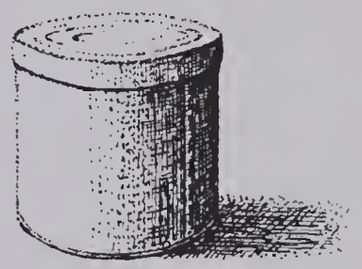
Wet sand and moist earth are excellent places to look for tracks. But the very best tracking conditions follow a snowfall. About twenty-four hours after a light snow is the best time for a tracking trip. Why?

Make Casts of Tracks

A good way to collect and study animal tracks is to make plaster of paris casts. Plaster is poured into a track and left to harden. The hardened imprint can then be taken back to the classroom and used to make similar tracks.

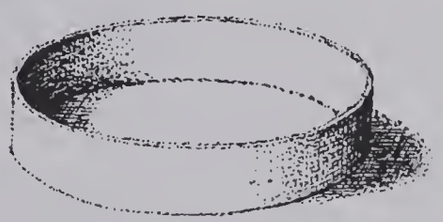
Here is a good recipe for making these casts.

1. Buy 1 or 1.5 kg of the finest plaster of paris available. Keep it in a tightly capped container.



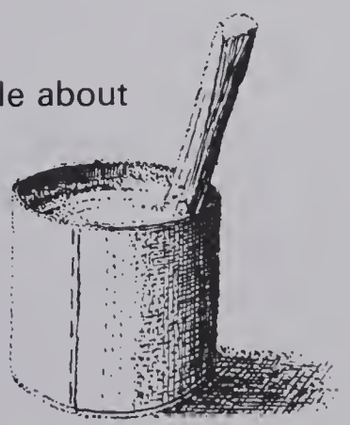
2. Collect several tin cans for mixing.

3. Cut slices about 5 cm wide from plastic bottles of various sizes (such as white plastic bleach bottles). These rings are used to enclose the tracks and act as dikes for the fluid plaster of paris.



4. Find a clear, fresh track in wet sand or damp earth.

5. Place a plastic circle around the track. (Use a circle about 2 cm wider than the track.)

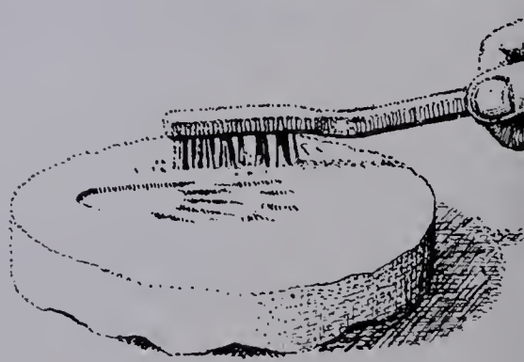


6. Put some plaster of paris in a can, add water, and stir with a stick until you get a thick, creamy batter. Tap the can lightly

to get rid of air bubbles. If the mixture is too thick, it will harden before it reaches all parts of the track. If it is too thin, it will take too long to harden. When the solution loses its watery feel and begins to thicken as you stir it, it is ready to use.

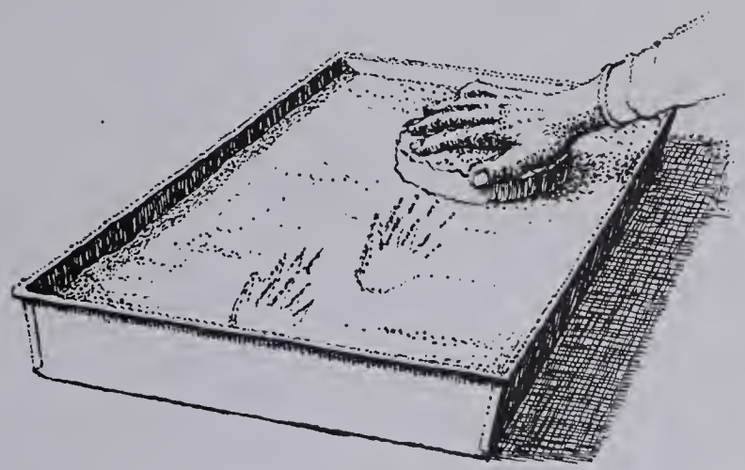
7. Pour the plaster into the circle and let it dry for ten minutes or longer. The amount of time will depend on the weather.

8. Cut around the hardened cast with a knife. Lift off the plastic ring. Place your fingers well underneath the cast and lift it gently.



9. Wash off the mud or sand carefully. An old toothbrush is good for this.

10. Write the date, the location, and the kind of animal (if you know it) on the back of the cast.



You can now use the cast to make tracks in a deep sand tray in your classroom. You can also make permanent track casts in another container of plaster of paris. Coat your first cast with vaseline so that it does not stick to the fresh plaster.

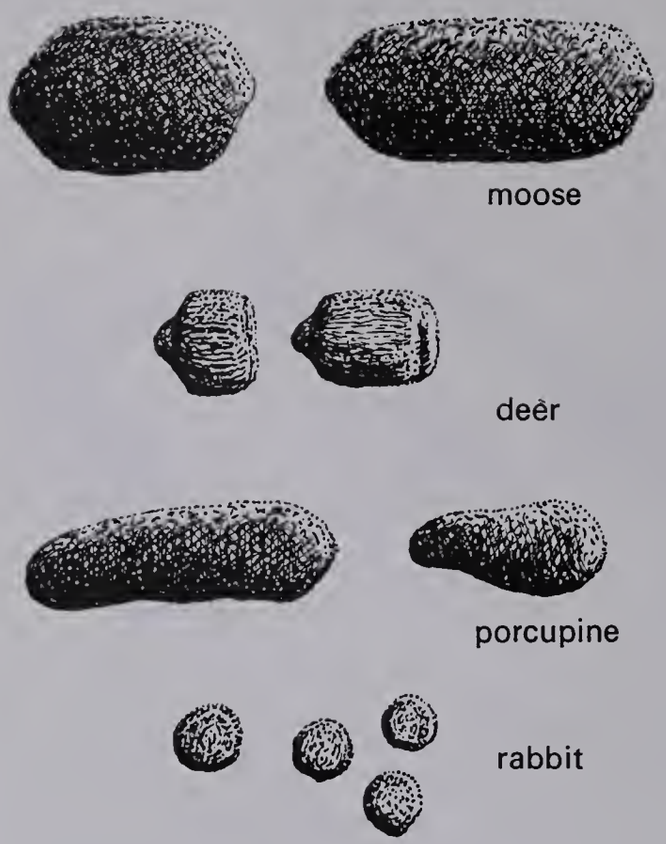
Scats Are Also Clues

There are other signs that often can tell you what animals are present in an area. Mammals leave "calling cards" in the form of droppings or scats. This is sometimes the first evidence that a mouse has found its way into a cupboard.

In the winter, when plant-eaters such as moose, deer, porcupines, and rabbits are eating twigs or bark, they leave behind droppings in the form of hard, dry, circular or oval pellets. The pellet of each species is slightly different. Rabbit pellets, for example, are almost round, and about 0.8 cm across. These pellets are the clues that tell garden lovers whose teeth have gnawed down their prize rose bushes!

Remains of food in scats also are good clues to what kind of animal has passed. Wolves, coyotes, and foxes prey on other mammals, and bones and hair often appear in their droppings.

Two-thirds natural size



Look for Signs of Feeding

List the main foods of the mammals found in your locality. How does their diet change from summer to winter?

Mammals spend much of their time searching for and eating food. If you know the foods they like best, you will be better able to look for them.

Why do meadow mice, woodchucks, cats, and foxes like grassy areas? Do they all like them for the same reason?

The common red squirrel of the northern evergreen forests is a seed-eater. Which seeds would be most important to him? How do you know? His cousin, the eastern grey (or black) squirrel, lives in broad-leafed forests. Which seeds might be his favourites?

Another clue to an animal's identity is the *way* he eats his food. In winter, meadow mice or voles often eat bark beneath the snow line. Rabbits and hares eat bark or twigs, but above the snow. After the snow melts, you would have to look for other clues to tell which mammal removed the bark.

Mice sometimes increase greatly in numbers, and they can do a lot of damage to trees. Often this damage is not noticed until the snow melts in spring. What types of farmers would suffer most from trees that are "girdled" by mice? (The outer bark is eaten off right around the tree.)

Rabbits and hares have chisel-like teeth that nip off twigs at a sharp angle. Deer and moose also eat woody twigs in winter, but they have teeth only in the lower jaw. (The upper jaw is a hardgum or palate.) These animals break off twigs leaving a jagged rather than a clean-cut edge.

How high can a deer reach compared to a rabbit? Can a rabbit cut twigs off three or four feet above ground level? When? What other mammal eats bark from trees. (Clue—he is a "fattie".)

Twigs bitten by rabbit and deer

Find Where They Live

Animal homes and food storage places are also clues to look for. Which of the mammals in your area use burrows? Which ones use burrows that other mammals have made? Some mammals use tree dens. Look for large trees with broken tops or with holes where old limbs have broken off. What sign might you look for if you suspected raccoons were living in a hole high up in a basswood tree? What might city raccoons use for dens? List the mammals and birds that might use a hollow tree.

Chipmunks and squirrels store seeds and nuts. You can sometimes see evidence that these stores are being used. Where do black bears store their winter food reserves?

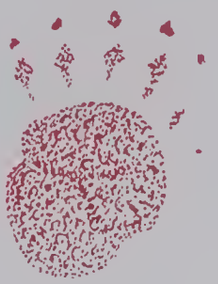
The following suggestions might make your outdoor work more interesting and provide a better understanding of the mammals you study.

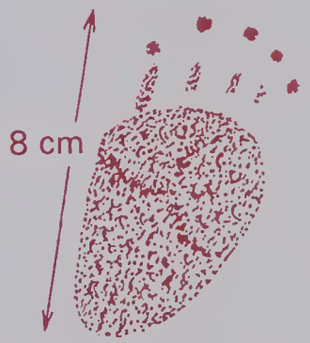
1. Make a complete list of the mammals for which you find evidence in your study area. List the evidence for each.
2. Find out in your resource centre which of these *families* of mammals your mammals belong to: raccoon, weasel, dog, cat, rodent, rabbit, hoofed animals.
3. On your sketch map, show the location of the homes of the larger mammals.
4. On your map, plot the activities of one larger animal such as a rabbit, dog, cat, or fox. (Follow his tracks after a fresh snowfall.) This may give you some idea of the area that is familiar to him—and you may actually discover him! Some

lynx

smaller mammals may spend their entire lives within an area a few hundred yards across. As a rule, the larger the animal, the larger his "home range". Why?

5. Make a list of the foods eaten by each mammal in your study area.
6. List the activities of the mammals that live in or travel through your study area.
7. Find a clear trail left by one animal. Measure and record the size of its tracks. Measure the distance between two prints made by its right front foot. (Take ten such measurements and average them.) You can then compare the average size of leaps taken by different kinds of animals.
8. Note any evidence you find that one mammal has influenced another in any way. Occasionally you may find where one mammal has chased or captured another.





Who Am I?

1. I have very large feet for my size. I change to a white coat in the winter. I like to eat bark and twigs. Who am I?
2. I am a member of the weasel family and I like water. My fur is dark brown and sometimes ends up in expensive coats for humans. Who am I?

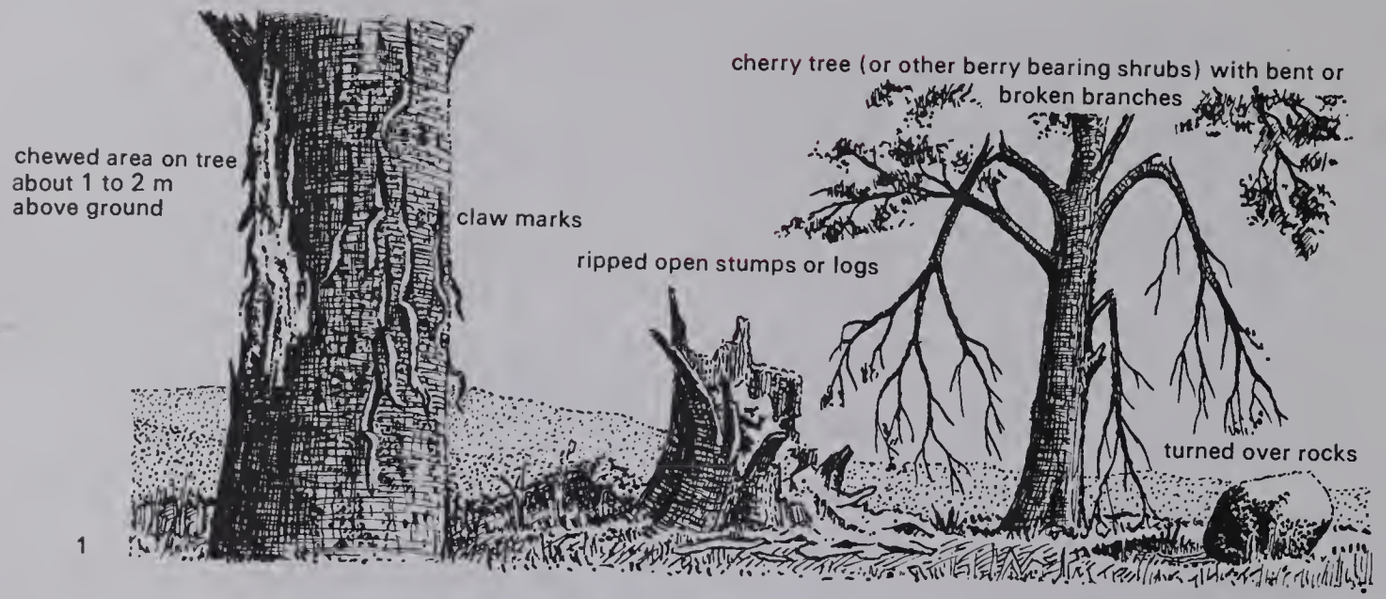
MAMMAL STUDY IN THE SPACE AGE

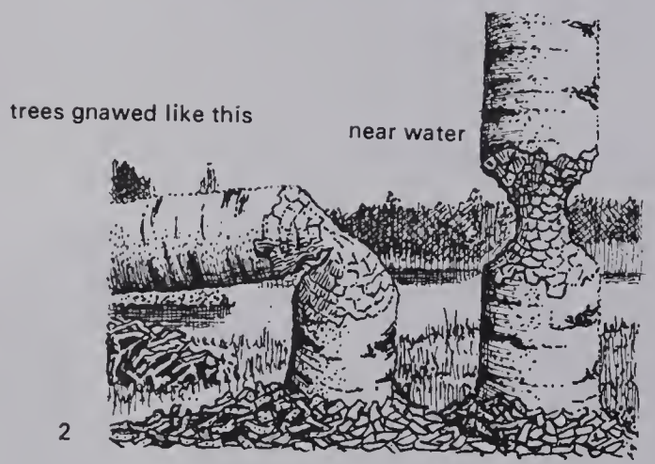
Much has yet to be discovered about wild animals and the type of habitat that best supports them. This lack of knowledge is not surprising. For centuries, humans have been careless in their treatment of animals and of the countryside in which they live. Most men believed that there was an unlimited supply of wild creatures for all time. But they were wrong. Species such as the plains buffalo have been reduced to very small numbers, and the passenger pigeon has disappeared altogether.

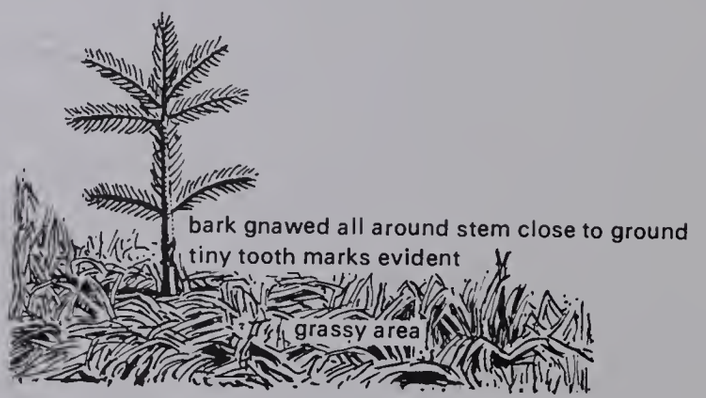
Only in recent times have we come to realize that we must manage wildlife carefully or we will lose it forever.

porcupine

Who Did It?


chewed area on tree about 1 to 2 m above ground
claw marks
ripped open stumps or logs
cherry tree (or other berry bearing shrubs) with bent or broken branches
turned over rocks
1


trees gnawed like this
near water
2


bark gnawed all around stem close to ground
tiny tooth marks evident
grassy area
3

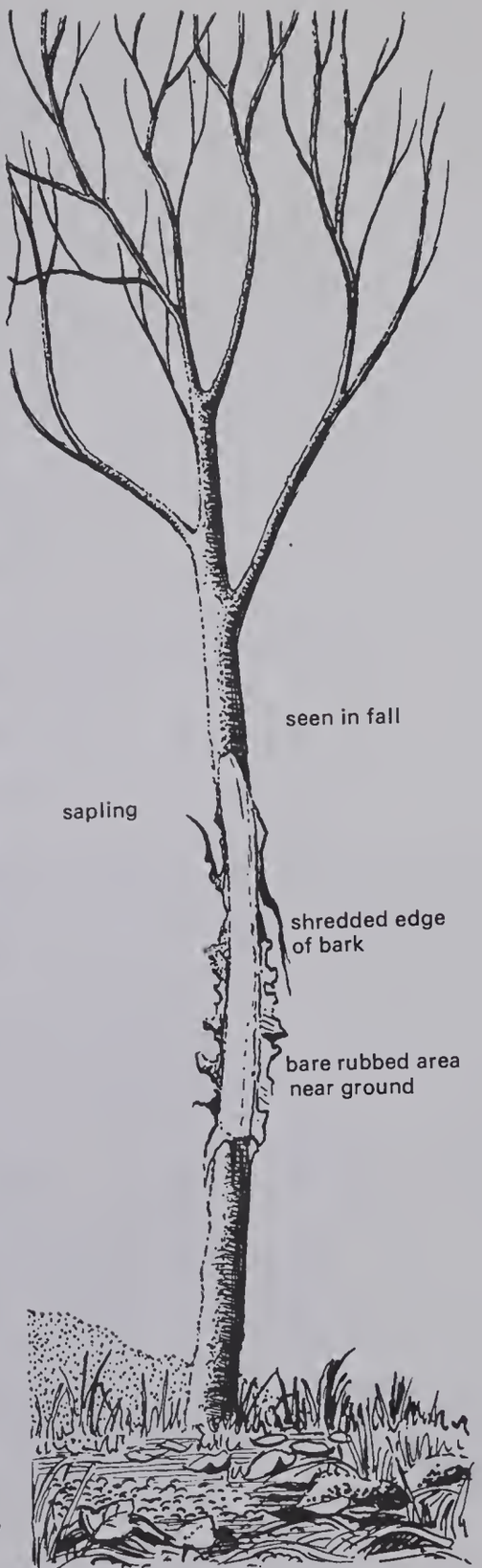
4
droppings on log (1 cm)
floating bits of stem, leaves
house made of cattails, sedge, etc.

5

network of surface runways in grass commonly in low-land areas

6

short lengths of grass stems found in small piles on floor of runways



7

Proper management requires facts, and the task of the wildlife scientist is difficult. Many wild animals are both shy and wary; many are active only at night.

Simple questions about wild animals are very hard to answer. How long does a bear live? How far does a moose travel? What do otters eat? How many deer live in a square mile of forest? How many healthy deer can that forest feed? These are only a few questions about a few animals. There are many, many more.

Animals don't talk—at least man has always found it difficult to communicate with them. Unlike a detective who questions human suspects and witnesses, the wildlife detective must use other methods to get answers.

The age of wild mammals is very important to those who must manage them properly. There are many different ways to age mammals. For instance, deer are aged by noting the wear on the teeth of their lower jaw, and Rocky Mountain Big Horn Sheep have a ring for each year of their age which shows on their large curved horns. Some mammals, including the black bear, grow at different rates at various seasons of the year. Much as annual growth rings are laid down as a tree grows, so do annual rings show up in the teeth of these mammals. The photograph below

striped skunk

The canine tooth of a black bear is removed, sawed in two, and observed through a microscope. A very small section of the tooth is shown in the photograph.

shows a cross section of the canine tooth of a 28-year-old black bear, as seen through a microscope. Can you count the rings? Do bears usually live that long? This bear lived in captivity all its life.

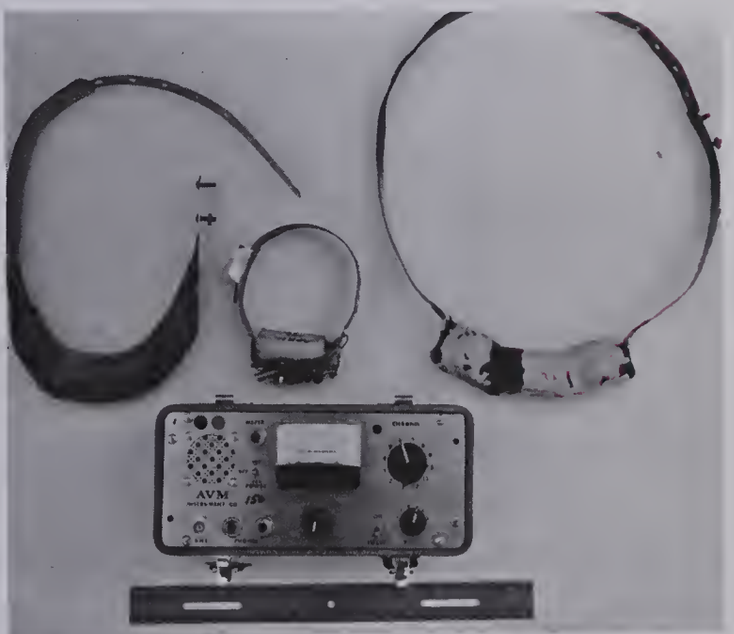
Did You Know?

That you cannot age a deer by the number of spikes on its antlers? Poorly fed deer grow small antlers. Deer living on fertile soil which produces nutritious plants grow the largest antlers.

Marking and releasing mammals is a very useful way to learn more about them. Page 49 of *Studies for Open Places* describes a method of capturing, marking, and recapturing small mammals so as to estimate their numbers in an area.

Marking is also useful in finding out other information, such as how far animals travel and how long they live. Coloured plastic collars and metal ear-tags, which clip onto an animal's ear much like a woman's earring, are two types of animal markers.

Ear tags and pliers and a plastic marking collar for a moose.



Radio equipment. The collars left to right fit deer, fox, and moose. The fox collar's radio is not yet encased in plastic. The receiver which picks up the radio signals is shown at the bottom.

Small transistor radios are now available. They can be attached to animals of any size—from polar bears to hummingbirds. These radios, which are miniature battery-operated transmitters, are constructed so that each one sends out a different signal. Radio receivers pick up the signal, and so we can know where the animal is at any time. What do you think are the advantages of this method of learning about animals?

Radio collar being placed on a polar bear by a wildlife biologist.

Biologists measure and tag a tranquilized polar bear.

Marking animals is one thing; capturing them is another! Although some of the smaller and quieter animals can be captured and handled without much trouble, others are either difficult to catch or dangerous to handle. These problems have been solved in several ways, however. For instance, moose spend a lot of time in the water in early summer, searching for tasty water plants and escaping biting insects. Helicopters can come down quickly on swimming moose and steer the moose into deep water while the ear-tag, collar, or radio transmitter is attached. One crew, trying to tag a very large bull moose, was surprised when the great animal suddenly rose up between the pontoon floats—the swimming moose had found some shallow water over a sand bar!

A helicopter steers a moose into deep water where ear tags or a radio collar can be attached.

A cow moose gets an ear tag.

In areas with few roads, how could you learn facts about moose that had been tagged with coloured neck collars?

To capture animals and to handle them more safely, special guns have been invented that fire darts filled with a drug that puts the animal to sleep. This drug is injected when the dart strikes. Why must care be taken to inject just the right amount of drug? Animals such as wild bears are handled very carefully and watched closely after being drugged. Why?

A dart gun is used to tranquilize mammals. The dart is made up of an injector needle, body, plunger, explosive charge, and a feathery tail for compression in the gun barrel and to keep the dart straight on course. The tranquilizing drug comes in the bottle.

Who Am I?

1. snowshoe or varying hare
2. mink

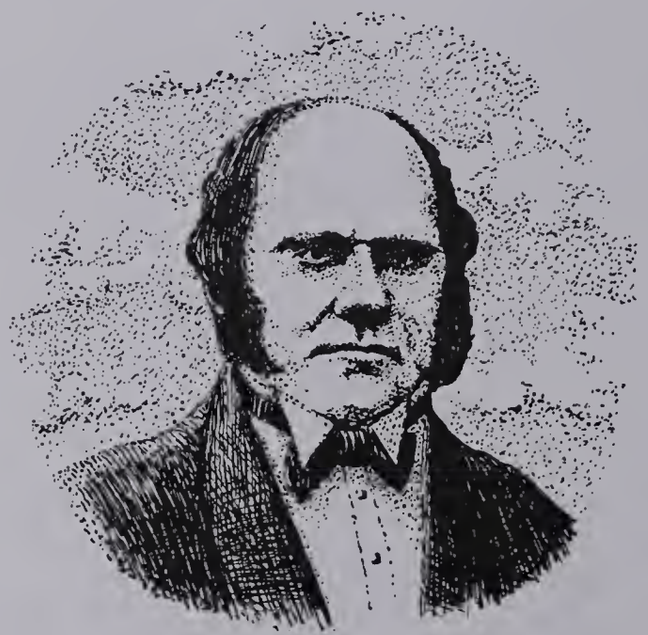
Who Did It?

1. black bear
2. beaver
3. meadow vole
4. muskrat
5. raccoon
6. meadow vole
7. white-tailed deer buck rubbing velvet from antlers

Chapter 3

ADAPTATIONS

Mammals are well suited or *adapted* to their homes and to the way they live. Some burrowing mammals have shovel-like front feet; tree-climbers have sharp claws. Mammals which live in water often have paddle-like feet and can hold their breath under water for long periods of time. All this has not happened by accident; these special features of animals have taken a very long time to appear. Over countless thousands of years, small changes have occurred in each species of mammal. Those changes that helped the animal to survive were more likely to be passed on to the next generation. Wild rabbits with good hearing, keen eyesight, and fast legs are likely to outlive those which don't have these. Why?



Charles Darwin sailed around the world on HMS Beagle, *observing living creatures at every place the ship landed. Find in your resource centre what evidence he found that led him to his theory of evolution.*

Charles Darwin was a naturalist who studied the ways in which animals are adapted for living. He believed that animals gradually change, or *evolve*, over a long period of time, by means of "natural selection"—"the survival of the fittest". Animals with characteristics which make them better able to survive pass along those traits to their offspring. Darwin's theories on evolution were first published in 1859 and are accepted as fact by most scientists today.

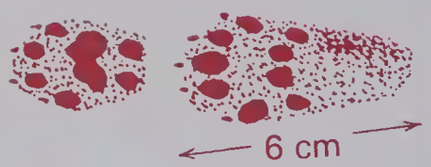
List some human characteristics which might cause man to become extinct. Why were dinosaurs not able to survive? List characteristics of the cave man which helped him to continue life. What do you think was the most important of these?

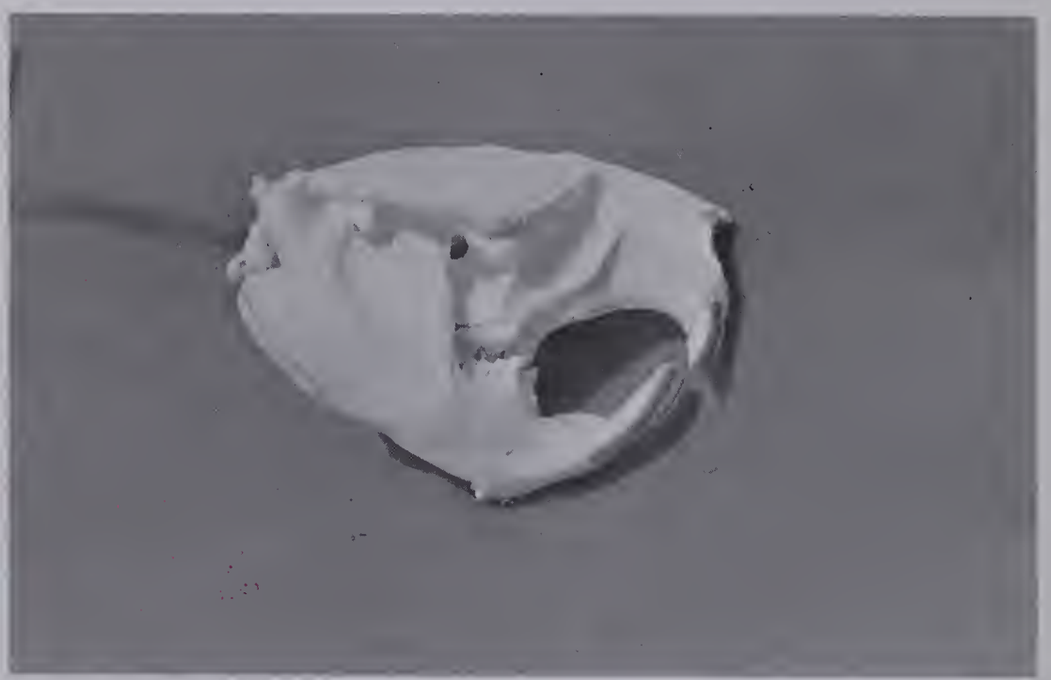
Mice appear to be quite successful, even though many creatures prey on them. What is one very important adaptation of mice which has assisted them in the struggle for survival? (See page 88.)

This replica of Tyranosaurus Rex is at Drumheller, Alberta, where many fossil remains of dinosaurs have been found.

ADAPTATIONS FOR LIVING

Scientists classify or group mammals according to similar characteristics, particularly in the way they eat or move about. For instance, one group is called the *Carnivores*. Carnivores, or flesh-eaters, have powerful teeth used for seizing, tearing flesh, and breaking bones. In this group is the dog family, which includes the wolf, coyote, fox, and dog. These animals all have sharp canine teeth and powerful shearing teeth. Do humans have any teeth like these? Watch a dog with a large meat bone and you will see which teeth shear meat from the bone.





Rodent teeth (a beaver skull)

grey squirrel

Many of the small mammals which eat plants belong to another group, the *Rodentia*, which includes all rodents. These mammals are usually rather small, and all have sharp, chisel-like front teeth used for gnawing off bark and breaking into hard seeds such as nuts. These front teeth, called incisors, grow continuously. Rodents wear them down and keep them sharp by grinding one against the other. Are rodent teeth a different colour from ours? Can you suggest why?

Which teeth are molars and which incisors? The beaver must constantly sharpen his cutting teeth; the lynx shown at right is a carnivore and does not.

Sometimes a rodent's jaw is badly formed or a front tooth breaks off so that the upper and lower teeth do not meet. This dooms the rodent to a slow death since the incisor continues to grow, preventing the animal from eating.

This groundhog had a badly formed jaw and so no way of keeping the constantly growing incisor tooth down to the right size. A normal groundhog skull is shown at right.

ADAPTATIONS FOR TRAVELLING

How an animal travels depends on where he lives and whether he needs to chase live food or escape from the jaws of a predator. Mammals which hunt or are hunted are usually the fastest; their legs are adapted for speed. Long legs are a definite advantage to a runner, and dogs and cats actually walk on their toes. The feet of the deer family have gradually evolved so that they now run on their "toe nails", which makes their legs even longer. Deer are built for speed. On the other hand, raccoons, bears, skunks, porcupines, and man walk "flat-footed"; these mammals are comparatively slow afoot. Put these animals in a list in the order of their need for speed: wolf, porcupine, squirrel, rabbit, bear, skunk, and raccoon. The wolf and rabbit require speed for very opposite reasons. What are they? The skunk and porcupine waddle along; they are real slowpokes. Why? The raccoon has habits that help him to escape some enemies. What are they?

A slowpoke

Whose Foot?

To which mammal does each of these feet belong? For what is each particularly suited? Where an animal lives is a good clue. Tree climbers need sharp claws; swimmers need web-like feet; diggers need large paddle-like feet with sharp claws. Answers are on page 59.

Match each foot with one of these mammals:

deer	*bear*	*muskrat*	*beaver*
mole	*squirrel*	*raccoon*	*wolf*
red fox	*skunk*	*bat*	*varying hare*

Did You Know?

That porcupines cannot throw their quills? But a healthy slap with a heavily-quilled tail is "porkie's" best means of defence and makes him a very dangerous opponent indeed. Most wild mammals leave porcupines alone. Are there exceptions to this general rule?

If a 100 m footrace between Canadian mammals could be arranged, who do you think would win? Draw or trace and cut out cardboard figures of the following mammals and arrange then at the finish line on a sand tray: wolf, black bear, snowshoe hare, jack rabbit, deer, moose, skunk, raccoon, vole, deer mouse, squirrel, pronghorn antelope and man. You will find clues to the order of finish on page 48.

Pronghorn antelope.

Group the mammals in the list which run fast or slow for the same reasons. For instance, some animals rely on speed to outrun their enemies, while others depend on different defences.

ADAPTATIONS FOR GETTING ENOUGH TO EAT

It is difficult for many animals to keep well fed, particularly in winter when many food supplies become scarce. But mammals have found different ways to survive these cold, bitter months.

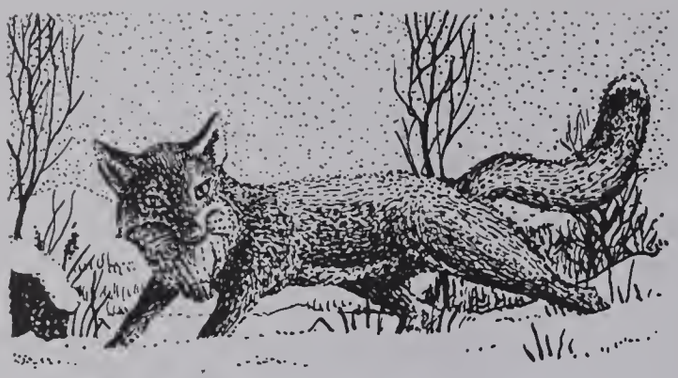
Some mammals, including the flesh-eaters and the large plant-eaters, are active all winter long. They spend a large part of each day feeding or looking for food. Others, including many small rodents, busily store food away during the warm months and eat it in the winter. Still others store their food as fat, then find a cozy hiding place and sleep most of the winter away. This last group may become active in mild weather, sometimes pushing their noses out of their dens to look around for a short while. Only two Canadian mammals hibernate: the groundhog and the thirteen-lined ground squirrel (gopher). Not only do these animals sleep all winter but they closely approach death. Their body temperatures drop to only a few degrees above the air temperature around them, their heart beats slow down, and they breathe in and out only a few times per minute. But just as if they had a built-in alarm clock, they wake up in spring, none the worse for their near-death sleep. Scientists have yet to solve the mystery of hibernation; exactly what causes it and ends it is still unknown.

List all the mammals you know under the following headings:

Active all winter
Food storers
Winter sleepers
Hibernators

white-tailed deer

Do active mammals eat more or less in winter than in summer? Why? Do you? Does your cat or dog? Under what conditions might wild animals starve during the winter months? Think of

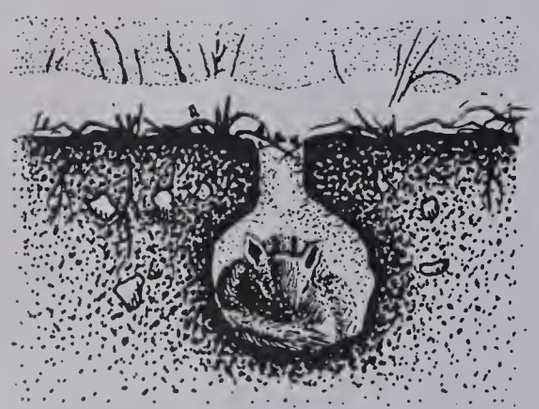


fox

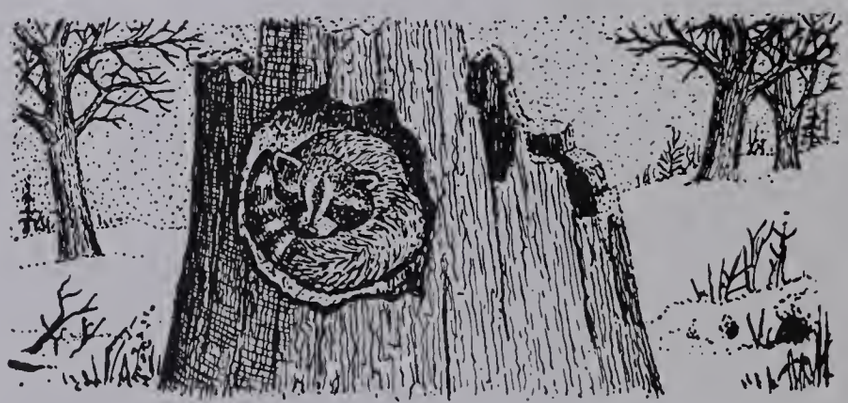
grey squirrel

groundhog

meadow vole



chipmunk



raccoon

Where some mammals spend the winter.

several species. The white-tailed deer, common to most areas of North America, is near the northern edge of its range in southern Canada. While skiers and tobogganers cheer at heavy snowfalls, deep snow for long periods may mean death to the deer, which in winter keep to narrow trails in the evergreen woodland where

red squirrel

black bear

lynx

weasel

beaver

they seek out shelter. When the food supplies (twigs of shrubs, bushes, and trees) beside the hard-packed trails are gone, the deer flounder through deep snow in search of food. When this happens the deer get weaker and weaker, and if deep snow remains for a long time, many deer may die.

When snow is deep, white-tailed deer use a network of trails like the one shown above to travel about their winter yards. If deep snow is present for long periods, food supplies next to the trails are eaten up and deer may starve.

Deer have a difficult time travelling in deep snow. Most of Canada is at the northern limit of the white-tailed deer's range.

Some mammals migrate, although not so far as most migratory birds. List animals which move from an area in autumn and return in spring. Several kinds of animals move up and down mountains with the changing seasons. They may not move as

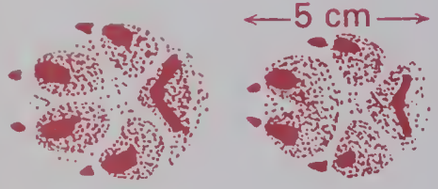
far as non-mountain species, but they move for much the same reasons. Which animals are they? One mammal usually goes south, sometimes for very long distances, like the bird which it resembles. Which one?

Barren ground caribou migrate in autumn, moving from the treeless tundra to the protection of forests further south, and return to the tundra each spring.

ADAPTATIONS FOR KEEPING WARM

Keeping warm goes hand in hand with obtaining enough food. Many northern mammals are specially adapted, or use part of their habitat to help them survive cold weather. Polar bears have a very thick layer of fat under a heavy, oily coat. Most mammals grow a heavier coat in winter, and some appear simply to be able to stand cold better than others. For instance, the white arctic fox and the Eskimo husky dog can sleep unprotected outside at -45°C in blizzard conditions.

Arctic mammals usually have very short ears and are generally "compact" in form. Why are these features important in a very cold climate?



red fox

red fox

arctic fox

Compare the head shape of the arctic fox with that of the red fox which lives in a warmer climate.

Do Eskimos differ in form from more southern races? Why?

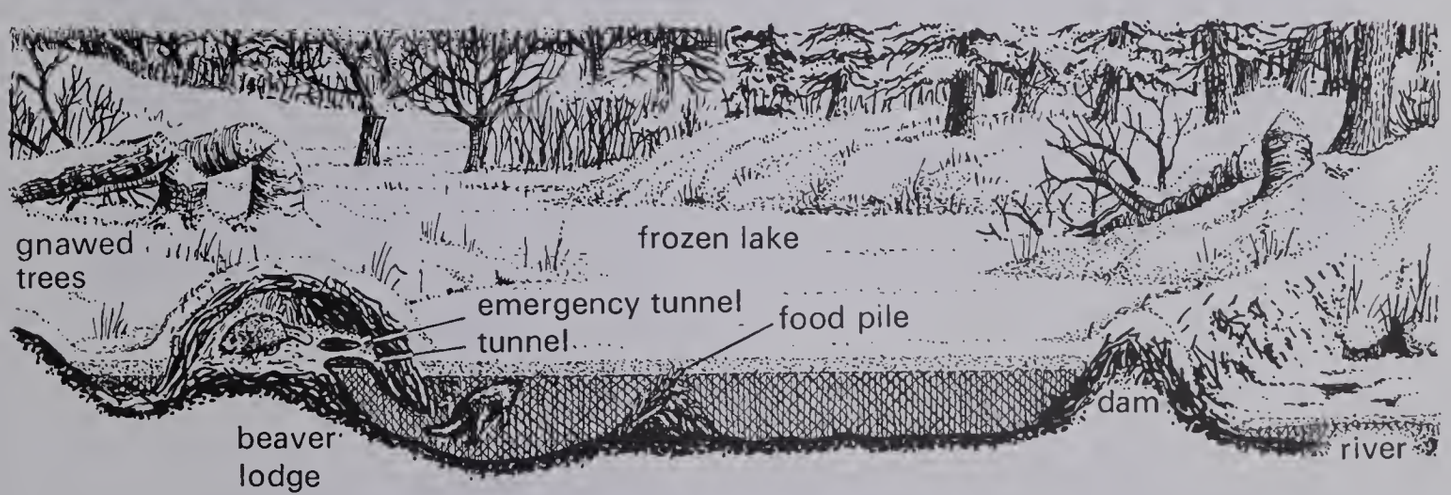
In winter, many animals survive the cold with the help of shelters—burrows, caves, tree dens, and houses or nests built of various materials. Sometimes a very simple wind break will make a big difference in the air temperature surrounding a mammal.

Design outside experiments showing the differences various types of shelter make in air temperature. If a pupil has a dog which lives in an outside doghouse, keep a record of temperatures inside and outside the house on cold winter nights.

The temperature always feels lower if there is a wind. Scientists call this wind-chill. Newspapers sometimes present daily wind-chill factors. Plot these day by day. What effect would constant windy weather have on mammals in winter?

Snow is very important to the survival of many species of small mammals, particularly mice and voles. To see why, put a thermometer in a dry sock or mitt and bury it at different depths in the snow. Take temperatures at the surface, 10, 20, and 30 cm beneath the snow, and at the level of the soil. Plot these temperatures on a graph. Where do most small mammals such as meadow voles spend the winter?

Ice is important to mammals like the beaver and muskrat which live in the water. Does a beaver encounter great changes in water temperature after the surface freezes? The answer is no, since, except for close to the surface ice, much of the water in lakes or streams in winter remains at about 4°C. One reason for this is the fact that water is heaviest at that temperature. In fall, as the surface water cools to 4°C, it sinks to the bottom. Most northern animals that live in water, like the beaver, otter and mink, have very valuable fur. Can you suggest why?



The beaver's habitat keeps him from freezing even in a frozen lake.

ADAPTATIONS WHICH PROTECT

Many mammals depend on others for food. The smaller mammals such as mice and rabbits are preyed upon by larger flesh-eaters. Mice, voles, and rabbits reproduce very quickly; this ensures survival of these species. Others, like the porcupine and skunk, which reproduce much more slowly, have obvious adaptations which protect them.

Some northern mammals, like the snowshoe hare, are brown in summer and white in winter. They change their coats during the spring and fall. This is called *protective colouration*. How does this change in colour help them to survive?

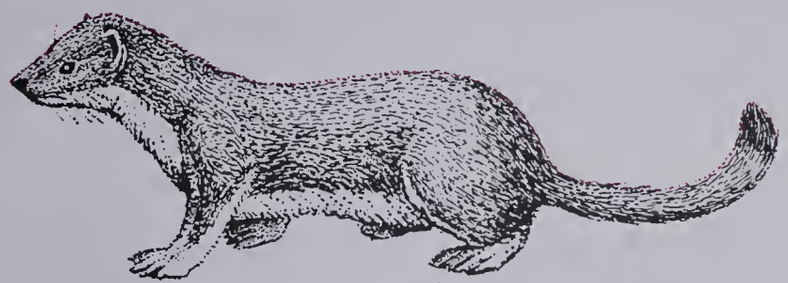
Nature has played a trick on this snowshoe hare, which lived near Ottawa, the capital of Canada. The picture was taken on December 20, when the ground in this area is usually covered with snow.

List mammals which turn white in winter. Has this adaptation evolved in each of these animals for similar reasons? Of what advantage is the white coat of the polar bear?

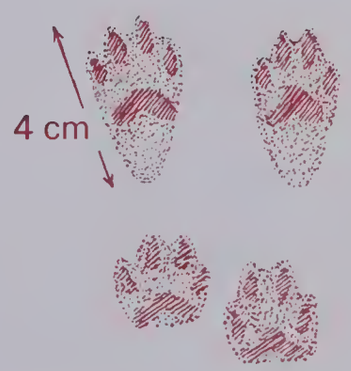
If a polar bear were brown, he might be warmer in the daytime. To find out why, take a piece of white cloth and a piece of black cloth and place them on snow. Keep snow brushed off the cloth. Record whether the black or white cloth sinks further into the snow over the period of one or two weeks. Why is this so? Why do humans in a hot climate often wear light coloured clothes? Compare a polar bear in a temperature of -45 °C diving into the sea and a human entering a sauna bath.

Whose Foot?

1. mole
2. deer
3. muskrat
4. red fox
5. beaver
6. varying hare
7. bat
8. raccoon
9. wolf
10. skunk
11. squirrel
12. bear



short-tail weasel



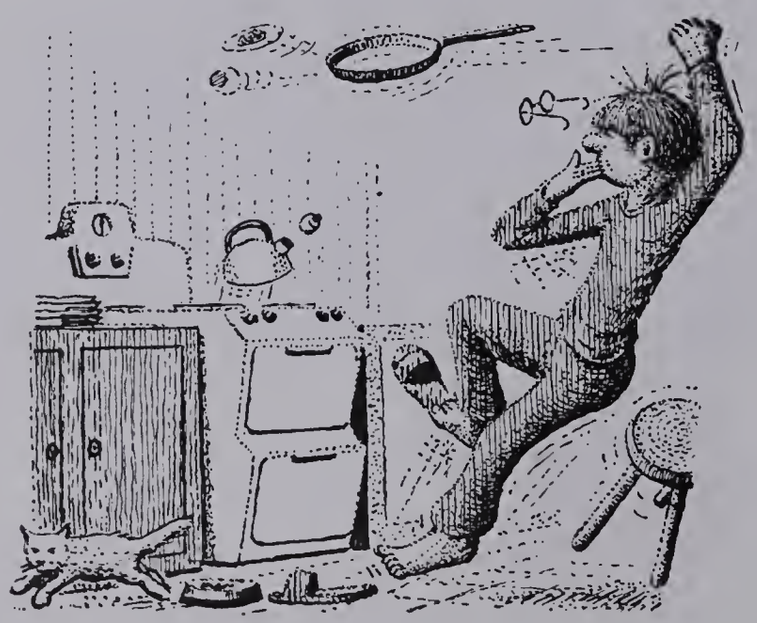
Chapter 4

MAMMAL BEHAVIOUR

What a mammal does is called behaviour; behaviour is always caused by a change in conditions, either inside or outside the animal. Some behaviour is instinctive. That is, the animal automatically does something without having learned to do it—no experience is necessary. A human shivers when he gets cold, a mouse feeds when it gets hungry, a deer gets more active at twilight and a puppy jumps at a sudden noise. Another type of behaviour is the result of learning. A puppy quickly learns to get used to noise if it is continued. Dogs and cats learn to come when called. Mammals sometimes learn by watching their parents or through their own experience. Some dogs, for instance, have learned to open doors.

Describe these actions. What does a dog do when he is hungry? What does a cat do when she wants to go out of doors?

When there is a change in conditions, a mammal will try to behave so that he will feel more comfortable. He will run from what frightens him. He will look for water if he is thirsty. If something strange crosses his path he will be bothered until he can cautiously find out what it is.



What is behaviour?

muskrat

7.5 cm

Animal behaviour and particularly mammal behaviour is very complicated and not well understood. Under the same circumstances various species will react in different ways. White-tailed deer, for instance, can live very close to man; a good number of deer live near even the largest of our cities. Grizzly bears, on the other hand, will not live close to man. They seek out very wild and undisturbed habitat. As man continues to increase in numbers and to populate remote areas, what effect will this have on the grizzly bear?

The white-tailed deer lives close to cities and towns, and gets along remarkably well in close association with man.

Another difference in behaviour can be shown with bears. If a human suddenly comes upon a black bear with cubs, the mother bear often will shoo the cubs to safety up a tree and then disappear herself. But because there are fewer trees in the high mountain areas where grizzly bears are normally found, the mother grizzly, if suddenly approached, will defend her cubs from an intruder. Grizzly bears, therefore, are much more dangerous than black bears, which rarely harm humans.

Mammal behaviour changes as a mammal grows older. Make a chart to show how some of your own activities have changed. For instance, do you play the same games that you played several years ago? What games have you given up? Do you like certain foods more or less now than you did when you were younger?

To protect her cubs, the black bear often will send her cubs to safety up the nearest tree.

It is very important that we understand how animals behave. An understanding of other mammals can give us a better explanation of why we act the way we do. Perhaps a better understanding of mammal behaviour will help man live a better and more peaceful life in the years ahead.

WILD MAMMALS

How can we study mammal behaviour ? Wild animals can be observed, as long as the observer is hidden and he does not interfere with the animals' normal activity. A blind or other hiding place is useful. It is better to accustom the animals to the observer over a long period of time, so that the animals go about their normal business without paying him any attention.

A simple blind will allow you to get much closer to many mammals. A fallen tree may serve as a blind.

When observing mammals in their natural setting, you should record all activity during a short period of time—perhaps ten minutes. Binoculars are very useful. Also remember that most wild animals are shy and are not active during daylight hours.

In some instances wild animals such as squirrels live near man, and these can be observed easily, in parks, around houses and even in the schoolyard.

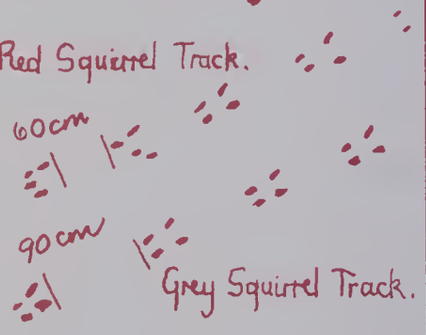
Domestic animals like dogs and cats are perhaps the best and easiest to study. You will be surprised at how little you have noticed or understood your pets' day-to-day behaviour when you study them more closely. And we should not forget the one mammal we can observe at any time—ourselves.

Sample Field Information Sheet 4a

Species	Number	Remarks
Grey Squirrel	One	Many tracks but only one squirrel seen. Binoculars used.

Date	Time	Location	Weather & Conditions
Dec 3, 1971	9:00 - 9:20	Centre Park Ravine	Clear 2 °C Snow 7cm deep with 1cm fresh snow

Type of Behaviour	Description of Activity and Remarks
Feeding (or Nest Building Fighting Courting Care-Giving Exploring Grooming or Clearing)	Squirrel sitting (resting?) on large lower branch of oak tree when first seen. After four minutes ran down main trunk and went straight to spot about 6m from trunk - dug with forepaws in snow and found what looked like acorn. Ran right to tree and climbed to large lower limbs. Turned object with paws, chewing it, for exactly 3 minutes and then ran down to spot near first digging. In 20 seconds dug and found another object and returned to large limb. Red Squirrel appeared 9 18 and chased grey squirrel from oak tree to a new tree further down the hill. Pieces of 10 acorns later found under the limbs. (Squirrel appeared to know right where acorns were under the snow. Did he bury them and remember the exact spot?)



When you record animal behaviour, include the date, hour, and weather conditions. List your observations on a chart under the following headings:

Feeding behaviour
Nest-building
Fighting
Courting
Care-giving
Exploring
Grooming

You may have some ideas about possible explanations of the behaviour you note. These ideas should be written down, but as they are not facts, they should be placed in brackets.

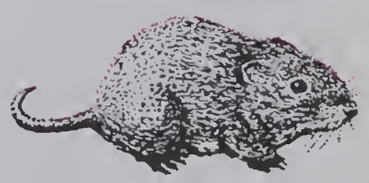
MAMMALS IN THE CLASSROOM

Mammals in the classroom may also be studied. How does an animal's behaviour change when he is moved to a larger cage? Given his favourite food? Given some fresh nesting material such as grass, wood chips or twigs?

It is tempting to explain all mammal behaviour in human terms, but this can be very misleading since other mammals have little reasoning power and just do not think as humans do. Stories about the wolf in Little Red Riding Hood, Snoopy or Wile E. Coyote tell us much about ourselves but very little about other mammals.

Many mammals have keener senses, such as hearing or smelling, than man. Although the dog has very poor reasoning skills, his nose has remarkable powers and tells him much about the world around him.

It is important to remember that most animal behaviour is different from our own. For instance, some humans expect deer, caribou or moose to be terribly frightened of wolves and, therefore, panic stricken when they know that wolves are nearby. This simply is not the case. Often these animals, the usual prey of wolves, will continue their normal activities, such as eating, even when wolves are in sight.



meadow vole

MAMMALS IN THE HOME

The dog and the cat are about the only mammals man has allowed to live with him. The dog has lived with man for some forty to fifty thousand years. The cat, on the other hand, is a relative newcomer to man's home; and, unlike the dog which has become completely domesticated, the cat has changed very little from the wild creature which first entered man's household. It is said that cats took up living in man's buildings only because there were more mice there than elsewhere. Because cat and dog behaviour are unlike each other, comparing the two animals can be very interesting. Describe the differences in behaviour of cats and dogs to commands from their masters. How do dogs and cats react when called? Do all dogs react the same way? Do all cats?

LEADERS AND FOLLOWERS

Many mammals which live in groups have leaders and followers. Within the group there are strong individuals who rule over the weaker ones. They often lead the group and get first pick of food and mates. Frequently the group has a whole series of strong and weak individuals; and, just as in an army, the lower ranking individuals look up to or are subordinate to the ones of higher

rank. In a litter of puppies of the domestic dog or the wolf, this ranking can often be seen, and sometimes it is easy to tell which one is "top dog". In a flock of chickens this rank is illustrated by pecking. The leader, who "rules the roost", can peck all the others. The second in line can peck all but the leader and so on. For this reason the organization within groups of animals has become known as "peck order" or "pecking order".

A dominant and a subordinate timber wolf. Note the straight, stiff tail of the wolf on the left.

What happens when two strange dogs meet? Have you noticed that they turn around and stand head to tail? You can tell which is the dominant dog by watching the posture of both animals, particularly how high each of their tails is held. Of two dogs of similar size, the one standing tallest with the most upright tail will be the dominant or superior dog—the "top dog"! A crouching dog with lowered tail shows his fear of the other. Under these conditions, dogs usually do not fight—or do not fight for long since one dog runs off. When two equals meet, however, the situation can more often result in a serious fight.

Three timber wolves. Which is the dominant animal? Which is the least dominant?

Some large dogs are capable of killing other dogs. But this rarely happens. A beaten dog will roll over and offer the underside of his neck to the winner. What do you think this action means? What do we call an individual or team not expected to win a sports contest? If you act crossly to a puppy, he will very often roll over on his back. Is this the same behaviour as described and shown above?

Each species of animal has different characteristics which are used to dominate others of its kind. For instance, the antler size in bull elk or moose is very important in determining which male will win when they are courting a cow moose.

Bull elk spar during the autumn mating season.

A cow elk stands by watching.

What do humans do to show subordination to royalty or to a person of much higher rank?

Act out a short play in which a great king, sitting on his throne, is receiving his subjects and listening to their requests. How did the actor who was king hold his body? his head? How did the subjects stand? Were the voices of king and subjects different?

ANIMAL TERRITORIES

Many animals space themselves out over the area in which they live. Each member of the species will make part of the area his own private property and he will chase others of his kind from his territory. Dogs will often chase other dogs off their owners' property. Even small dogs on "their" property appear to be able to keep larger dogs away. How do dogs mark their territories? Are posts, trees and hydrants useful? Dogs always seem to be stronger and more dominant when they are on familiar ground. This is so with many mammals including man. Do you think a home team has an advantage in a sports contest?

Humans also have their own "territories". Not only are we most comfortable in our own homes, but each one of us has a distance he likes to keep away from others. The next time you talk with someone face to face, try to get closer to him. What does he do? At what distance are you most comfortable while talking with someone? People in some countries are comfortable "face to face" at closer distances than people in others. They have smaller "individual territories".

black bear

FIGHTING

Most fighting between mammals happens between members of one species. Moose fight with moose, deer with deer, dog with dog, and man with man. Sometimes this fighting is done to decide which will win a mate, other times to determine which will win and hold a territory or position in a "peck order".

Fighting for other reasons happens only rarely in the world of mammals, with man being an exception to the rule. List reasons for men fighting with one another.

When mammals (including boys and girls) are faced with an unpleasant situation, they often are not certain whether to fight or run away. The mammal body prepares itself for either fight or flight, and many times very small things make the difference between fighting and running away.

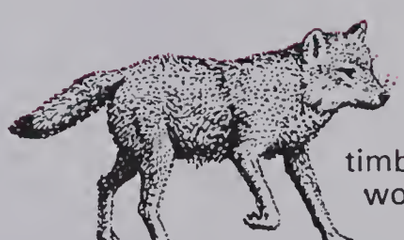
Often the mammals are not certain whether they will win, so they bluff each other, really afraid to fight. You have seen boys in the schoolyard threatening each other. What are some of the things they do if they do not actually fight?

Staring is one form of threat, and this is why it is so difficult to outstare another person, and particularly a stranger. Humans, instead of fighting, often jump up and down ("hopping mad"), clench and wave their fists (well out of range of their opponent), frown, purse their lips and use words to threaten the enemy. It is said that an enemy "white with rage" is more dangerous than a red-faced one, who is less sure of himself.

Most mammals fighting face to face do not seriously damage their opponents, because the beaten one usually runs off before too much damage is done. Frequently the victor wins without actually fighting at all. Why does this not happen in wars waged by humans? Do you suppose that early man may have fought more like other mammals? If so, what might have changed this?

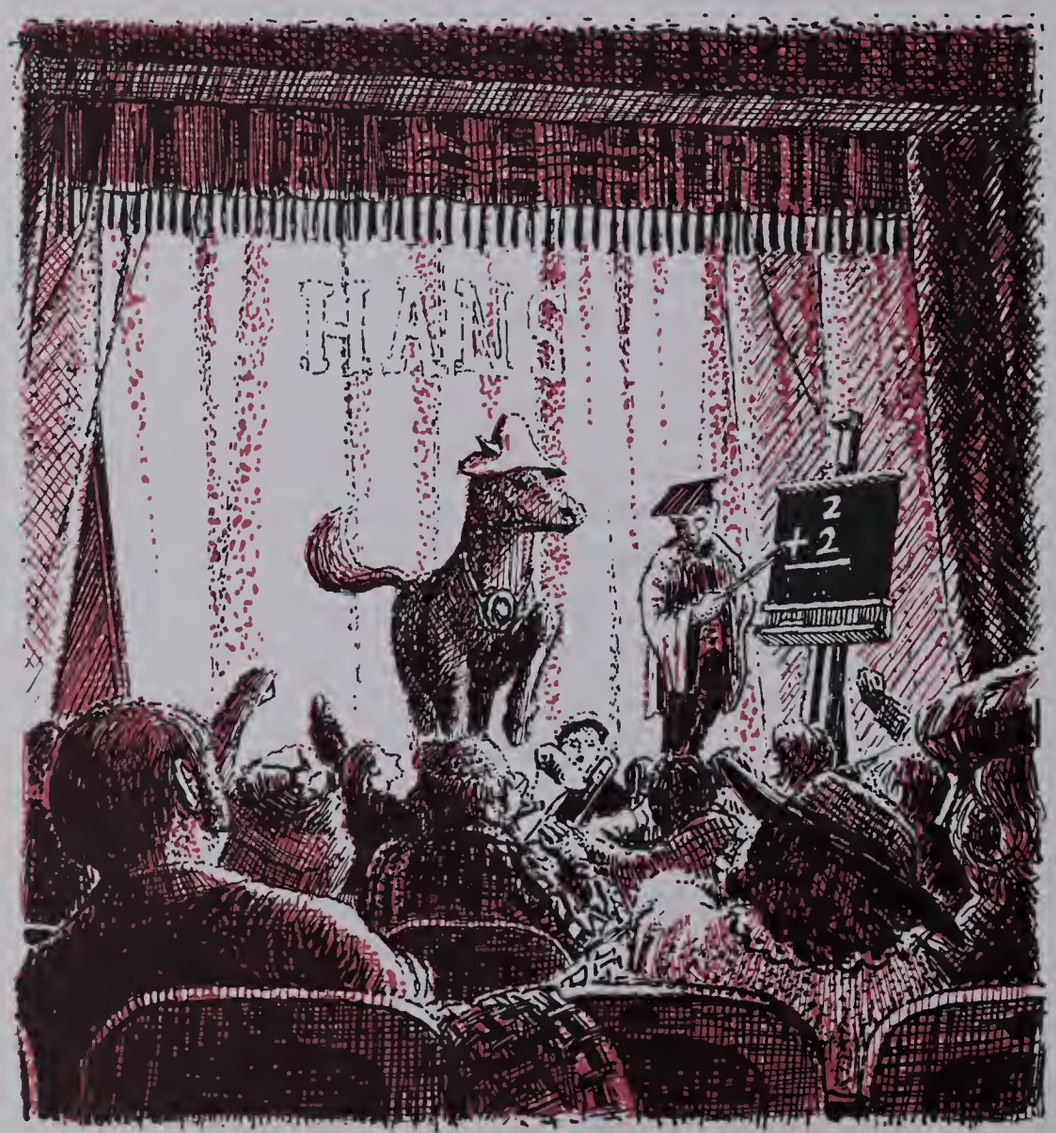
COMMUNICATION

How do animals communicate or "talk" with one another? Unlike humans who do most of their communicating with one another by voice, many mammals produce few sounds. But most have very keen senses and are much better at observing than humans. An example of this was a famous German horse named Clever Hans. His master taught him to count by tapping the ground with his hoof. The horse even learned to tap out the answers to problems in arithmetic such as simple addition or



timber wolf

subtraction; he would stop his foot-tapping when he reached the correct answers—much to the amazement of the hundreds who came to see him perform. But Clever Hans would stop at the correct answer only when the audience knew the answer—and only when he could see the audience. Why? This has been true of other "clever" animals. Unable to see the reaction of humans who knew the answers and who unknowingly "told" (by changes in their behaviour) the performing animal when he had reached the correct number, the counting animals always failed their tests! Is it easier to tell the way you feel to someone over



the telephone or face-to-face? Why? A dog in a car at night often seems to know when he is approaching home. Can you think why?

Watch one of your pets closely to see how he communicates his feelings to you by his movements and facial expressions. When animals lay their ears back, what does this indicate? List yours pets' actions which show fear, joy, anger and curiosity.

The keeper of a zoo was writing to another zoo for a mongoose for his collection. He actually wanted two of these animals but he didn't know the correct plural of mongoose. Mongooses? Mongeese? So he said, "Please send me one mongoose—and perhaps while your at it, you might send me another."

raccoon

Chapter 5

MAMMALS IN YOUR CLASSROOM

The best place to study mammals is in the out-of-doors. But since most wild mammals flee or hide when humans approach, it is helpful to have mammals to study in your own classroom.

The table on page 78 will help you in picking mammals for your classroom and will guide you in caring for them.

It is best to choose young animals, as they will get used to being handled more readily than older ones. Before being handled, however, animal visitors must be given a chance to get used to their new surroundings. It is hard to resist taking them out of the cage and petting them when they first come to the school, but in fairness to the animals this should not be done. Give them at least twenty-four hours to "settle in" before you disturb them.

HANDLING

Once an animal is used to his new home, you should begin to get to know him. Regular handling, if done properly, is important in taming him. He must learn to feel that he is safe in your hands.

Animals—and human babies—can sense when they are being handled by someone who is afraid to pick them up. How do you think they can tell? What are the ways in which you don't like to be "handled"?

Before and after handling the animals you should wash your hands with strong soap. Why is this necessary? Think in terms of the animal as well as yourself.

The "scoop" method is the best way to pick up the smaller mammals. You simply cup the animal in your hands as though you were scooping up water to drink. By cupping your hands under and around him, you can lift him slowly and gently without frightening him. The animal should be lifted facing you, in case he tries to jump out of your hands. If he is facing you, a jump will carry him into your body, where he can be cradled so that he will not fall and be injured.

The "scoop" method is useful for picking up small animals.

To pick up larger mammals, follow the method given in the table.

Note the position of the boy's hands.

CAGES

A number of cages for keeping mammals are described in *Studies for Open Places*, page 50. You may use the materials shown there to make a larger cage, depending on the size of your animal. The table tells you the smallest your cage should be, but you can make it larger if you wish.

Whether you are building a cage or buying one, the following should be kept in mind.

1. The cage should be large enough for the animal to move around and exercise in.
2. It must be escape-proof, with the screen firmly joined to the frame and strong hooks on the door.
3. It must be well ventilated so that the animal gets fresh air to breathe. Why else is good ventilation important?
4. The material must be rot-proof.
5. The material must be of some kind that your animal will not chew.
6. The cage must be easy to clean (that is, you must be able to reach every corner with your brush or cloth) and made of materials that can be washed with soap and water.

Cages must be cleaned with care regularly. This is important for the health and comfort of both the animals and the people in the classroom. Cages that have been left to get dirty have a very unpleasant smell.

Regular cleaning is important to the health and comfort of classroom mammals.

For most small mammals, once a week is enough. This method of cleaning will keep the cage sweet smelling and free from germs.

1. Throw out all the old bedding material.
2. Wash the cage with warm water and detergent.
3. Wipe the cage down with clean water in which you have put some non-poisonous disinfectant. (Your druggist will tell you what disinfectants are safe to use for this.) Twenty-five grams disinfectant in a litre of water is about the right mixture.
4. Make sure the cage is thoroughly dry before you add fresh bedding material and put the animal back in. Why?

The only time you might let the cage go past its regular cleaning day is when there are very young babies in it. Wait until the young have grown enough to leave the nest on their own. Why should you not clean the cage during this period?

Mammals Suited for the Classroom and their Care

Mammal	Food	Cage size L W H	Bedding and nest material	Handling
Golden Hamster *(mesocricetus auratus)*	rodent pellets, dried grains, fresh greens, sunflower seeds	45 cm x 30 cm x 20 cm for a pair or a female and litter	sawdust, shredded paper	"scoop" method
Mouse *(mus musculus domesticus)*	pellets, mixed grain, occasional fresh vegetables	40 cm x 25 cm x 15 cm 4-5 adults or a pair and litter	sawdust, paper towelling	"scoop" method
Rat *(rattus norvegicus albinus)*	rodent pellets, mixed grain, fresh vegetables	45 cm x 30 cm x 25 cm 4 young rats or a female and litter	sawdust, paper towelling	"scoop" method
Mongolian gerbil *(heriones unguiculatus)*	rodent pellets, mixed grain, carrot, lettuce	45 cm x 30 cm x 25 cm pair plus litter	sawdust, paper towelling	"scoop" method
Guinea pig *(cavia porcellus)*	clean hay, fresh greens, small pellets 0.5 cm (5 mm)	60 cm x 45 cm x 35 cm breeding pair or a female and litter	sawdust, clean hay	Lift gently with 2 hands, one hand under rump, other back of neck. Cradle in arms.
Rabbit *(oryctolagus cuniculus)*	pellets, fresh greens	60 cm x 45 cm x 45 cm one rabbit 90 cm x 60 cm x 45 cm female and litter	sawdust, clean hay	Place one hand under rump. Grasp loose skin on back of shoulder with other. Lift with both hands.

Length of gestation	Litter size	Weaning age	Weaning weight	Life span	Special care
16 days	5-7	21 days	40 grams	1-1½ years	wood to chew (wooden spool)
20 days	8-11	20 days	12 grams	1-1½ years	Male mice produce strong odour. Clean cage often.
21 days	9-11	22 days	35 grams	2-3 years	Rats are more gentle when kept in pairs.
25 days	4-6	21 days	14 grams	3-3½ years	Use great care in handling. Very active and may be dropped.
63-72 days	3-4	14 days	170 grams	3-3½ years	Be calm and gentle. Always keep males separate.
30 days	4-6	56 days	1000 grams	4-5 years	Do not place on a slippery surface. May panic.

All of the above should have water available at all times. They should be kept in a dry place free of drafts.

ANCESTORS

Our own ancestors came from many parts of the world. Several of the animals that are popular in classrooms were also brought from other parts of the world.

Choose one of these—hamsters, gerbils, guinea pigs—and see what you can find out about their ancestors.

1. Where did the animals come from? Locate the place on a map of the world.
2. What route are they most likely to have followed coming here? How far would they have travelled?
3. What type of surroundings (habitat) would these animals have if they lived in in their native land?
4. How would they live in the wild state? (Do they burrow in the ground? What do they eat? Are they active by day or by night?)
5. What could you do to make the cages of these animals as "home-like" as possible?

BREEDING

The table on page 78 shows us that for a female mouse about 20 days pass between the time when she mates and the time when the young mice are ready to be born. This is called the *length of gestation*. She then has to nurse them for about 20 more days, until they are *weaned* (that is, they stop nursing). In another 20 days or so, she will be ready to mate again and start another litter. This species of mouse then gives birth about every 60 days.

About how many litters will she produce in a year?

If she produces 8 mice in each litter, how many offspring will she produce in a year? (As the year goes on, of course, her children will start having children who will start having children!)

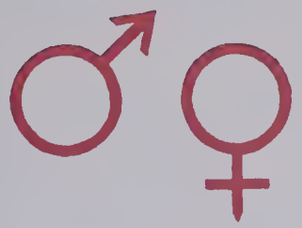
Page 90 describes an even faster reproducing species—the meadow vole, which reproduces about every 21 days under suitable conditions.

A breeding pair of porcupines produce only one offspring in

one year. Compare this with your results for the mouse. Why do you think mice have so many offspring and porcupines so few?

On the average, with any mammal, half of the offspring will be females and half will be males. Biologists show the sexes by these two symbols.

What do these symbols look like to you? Try to find out why these symbols are used.



KEEPING GROWTH RECORDS

Human children do not grow at an even rate. At some ages they grow very slowly, and at other ages they "shoot up like weeds". Two different boys will grow differently, and boys and girls will grow differently. Is the same true of other mammals?

Measure the mass and length of your classroom animals as they grow, and keep your records in a table like this.

DATE	MASS IN GRAMS	LENGTH
JUNE 5	115	
JUNE 6	120	
JUNE 7		
JUNE 8		

Make these measurements once a week, and always on the same day of the week. If an animal squirms and is difficult to keep on the scales, put him in a sock or a box, and subtract the mass of the sock or box from the total mass. An animal as small as a mouse will be hard to measure. Why? Make two graphs to show each animal's growth—one for mass and one for length.

Did the animal grow at an even rate? (Are the lines on the graphs straight?) Did different animals grow at the same rate?

THE IMPORTANCE OF GOOD DIET

For this activity you will need young rats (weighing 50-60 grams). You must have at least two rats, and more is better. Separate them into two cages, and label one cage Group A and the other Group B.

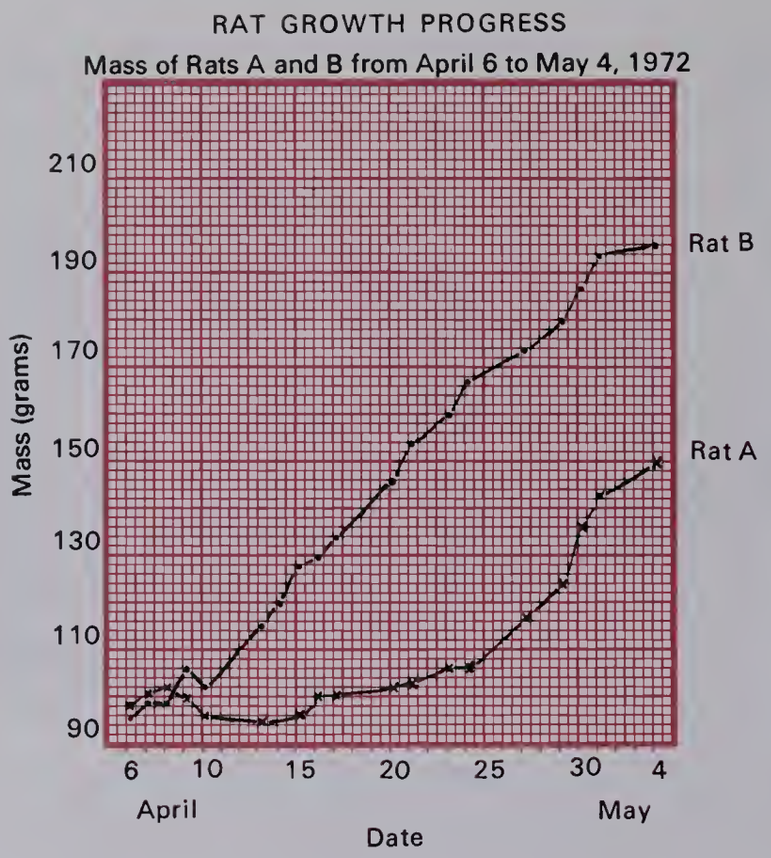
1. Feed Group A a diet of soft drinks, doughnuts, and bacon fat. Feed Group B a diet of milk, whole wheat bread, lettuce, and raw carrot. Both groups can have as much of the food on their diets as they want to eat. Both groups should also have fresh water to drink at all times.

2. Measure the mass of each group every day, and record the results in a table. (You could measure the whole group at once, and record the *average* mass.)

These two rats were taken from the same litter but have been placed on different diets.

3. Keep a daily record of what you observe about the condition of the rats. List your findings under these headings:
   Hair—(slick, smooth, scrubby, sparse)
   Eyes—(bright, deep pink, dull, pale)
   Ears—(pinkish, pale)
   Tail—(firm, pink, scrawny, greyish)
   Manner—(friendly, relaxed, shy, nervous)
4. After 10 days, put the rats in Group A on the same diet as Group B. (They should not be left on the other diet any longer. Why?) Continue with the records and the other observations.

One class did this experiment and got the following results:



Construct a graph using your own figures. Were your results similar to theirs?

Refer to Canada's Food Guide and to health reference books to find out what nutrients Group B was getting and Group A was missing. Which foods on each diet contain these nutrients?

proteins	minerals:
fats	*calcium*
carbohydrates	*iron*
vitamins	*phosphorus*

HOW LONG DO THEY LIVE?

Look again at the table on page 78. What is the relationship between the size of the animal and the length of time it lives?

Make a list of ten other mammals—some small, some medium-sized, and some large—and put them in order from smallest to largest. Find out how long each lives. Is the relationship you found still true?

THE PERIOD OF GESTATION

Look again at the table. How does the size of the animal compare with the length of the period of gestation?

The guinea pig does not fit in with this pattern very well. How are the newborn guinea pigs different from the newborn of the other animals? How does this explain the guinea pig's long gestation period?

Can you find the length of the gestation period for the other mammals you listed in the last activity? Is the pattern still the same?

HOW ACTIVE IS THE ANIMAL?

It is easy to see whether or not an animal is moving about, but it takes some careful thinking to design an experiment to *measure* how active he is.

One suggestion is to determine the amount of time he spends on an activity wheel, or to count how many turns the activity wheel makes. (An activity wheel with a counter to record the number of turns is available from the Webster Division of the McGraw-Hill Company.)

Some children tried sprinkling flour on the floor of the cage, so that they could trace the animal's movement by his tracks. Can you think of other ways of doing this?

A gerbil exercises on an activity wheel.

Once you have found a way of estimating the amount of movement, you can begin thinking of how you can find answers to the following questions.

1. Is the animal more active at some times of day than at others?
2. Are young animals more active than older animals?
3. Does the amount of light affect the amount of activity?
4. Does the temperature of the room affect amount of activity?
5. Is an animal more active when he is alone in his cage or when he has company?
6. What effect does noise have on amount of activity?
7. Does the size of the cage affect the amount of activity?

HOW MUCH FOOD DOES THE MAMMAL EAT?

Very carefully weigh all the food given to your classroom mammal. Collect the uneaten food each day and subtract its mass from your first figure.

Food can be weighed before and after feeding to find how much has been eaten. Be sure the animal has not spilled any.

1. Does the age of the animal affect the amount eaten?
2. Are there regular times at which the animal eats?
3. How does the amount the animal eats compare with his gain in mass?

4. Do lower temperatures result in his eating more food?

What other questions come to mind about the animal's eating habits?

MEASURING HEARTBEAT

It is very hard to measure the rate of heartbeat of a classroom mammal. You might be able to feel the heartbeat of your cat or dog. But it is easiest to perform your experiments on humans—yourself, your friends, and your family.

Can you think of a way to find answers to these questions?

1. How does activity affect the heartbeat rate?
2. How does body size affect the heartbeat rate?

3. Does age affect this rate?
4. Do boys and girls have different rates?

What other questions can you think of?

RABIES

Humans share certain diseases with other mammals. The most serious of these is rabies. What is rabies? How do people catch it? How is it prevented? How is it cured?

A visit to the class by a doctor or a veterinarian might help to clear up some of these questions.

Chapter 6

MAMMAL ECOLOGY

Ecology is the study of living things in the place in which they live. The word comes from the Greek word *oikos*, meaning house. Because in any community of living things there are a great number of plants and animals, all affecting one another, the science of mammal ecology is not a simple one. In this chapter, we will study some of the ways in which mammals live with each other and with plants in a natural community.

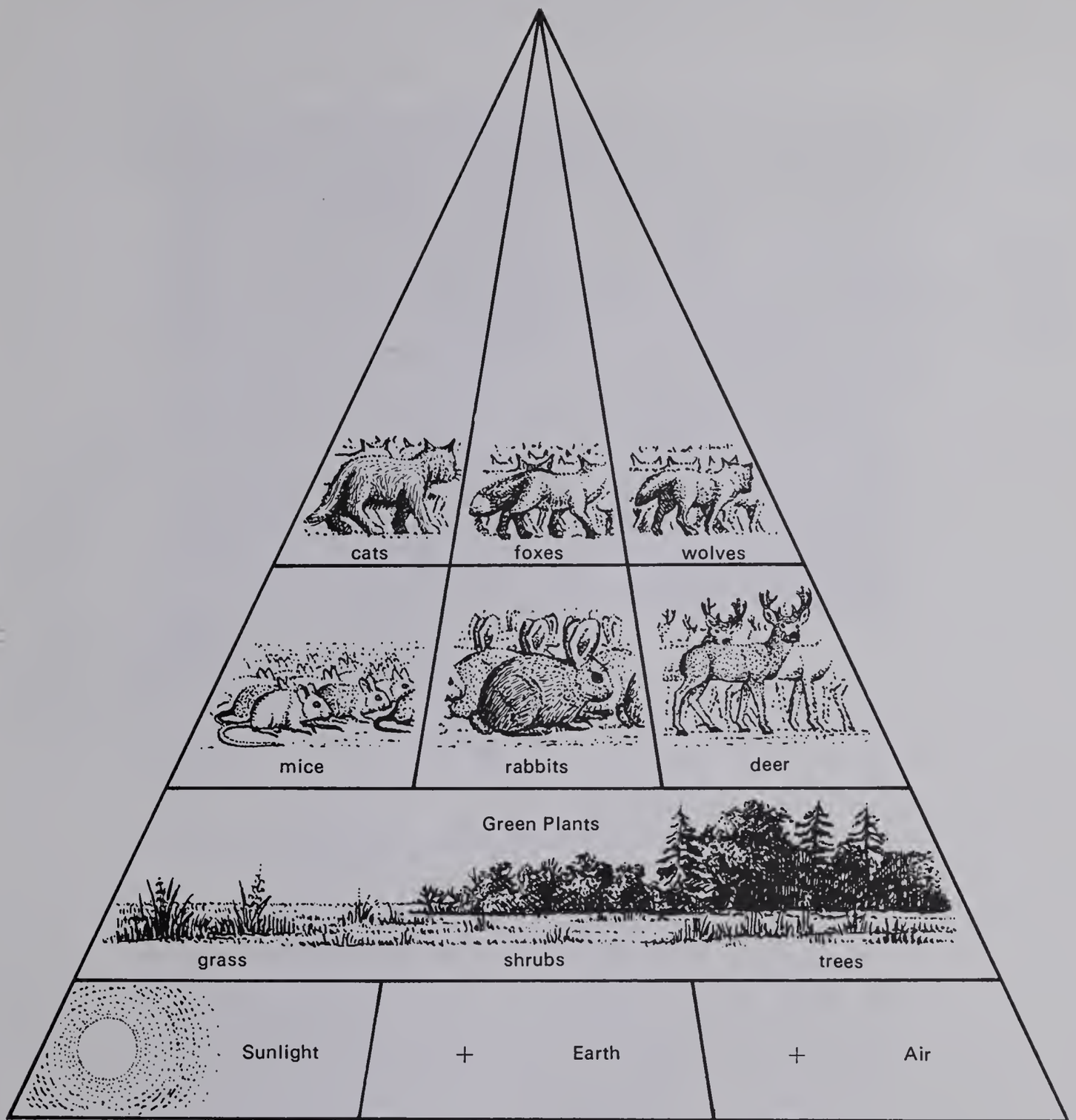
Just as the lower foundation blocks of a pyramid support the upper blocks, green plants are the foundation on which all mammal life depends. All living things on earth need energy to survive. This energy comes only from the sun, and green plants, using sunlight, can capture this energy. All other living things must get their energy directly or indirectly from plants. Some mammals—the Herbivores—eat plants, while others—the Carnivores—get their energy from eating other animals. Some mammals, like man, eat both plants and animals.

Look at your dinnerplate closely the next time you eat. The energy in that hamburger may be sufficient to hit a ball right over the fence!

PREDATORS AND PREY

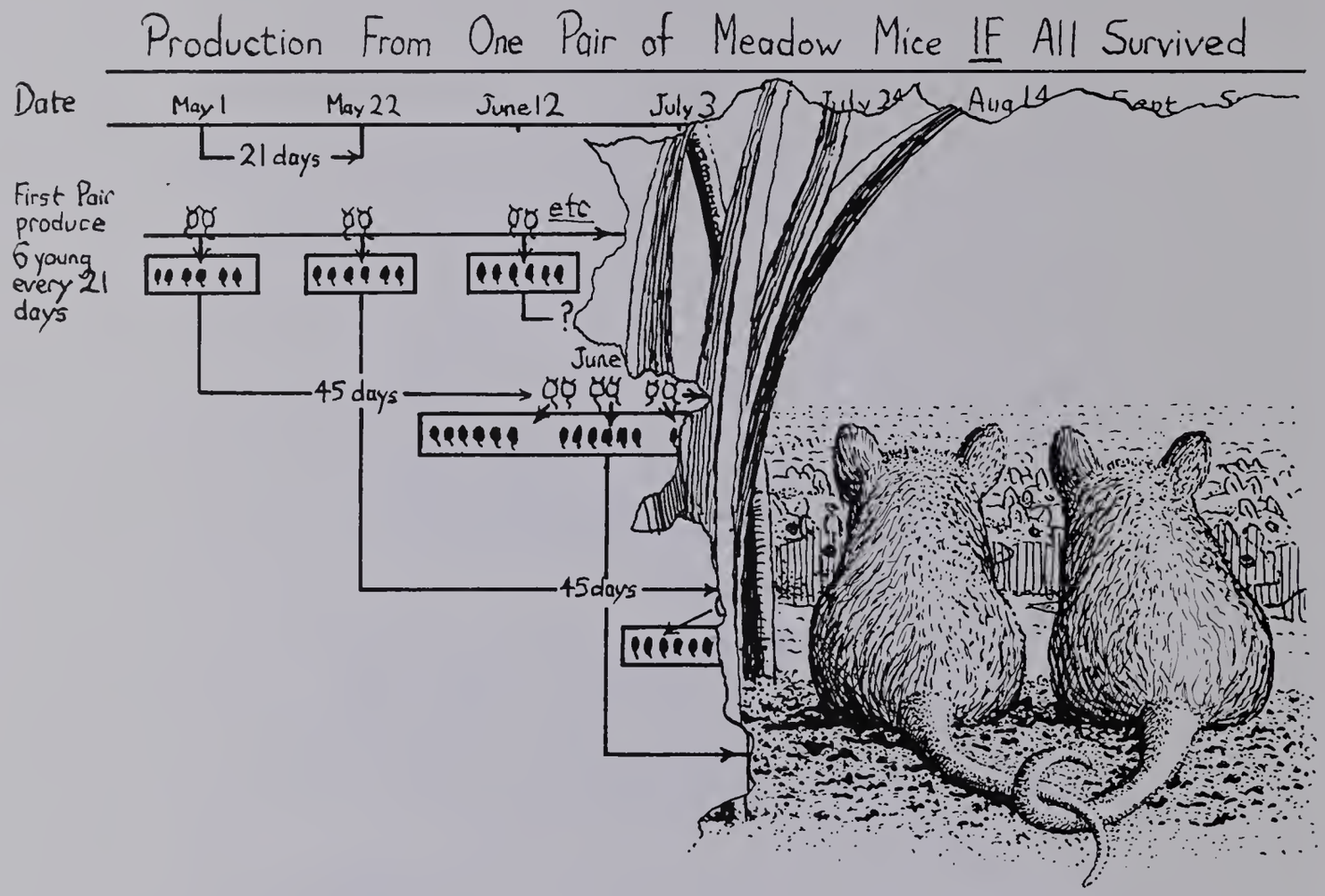
As a rule, the mammals that are preyed upon by others are smaller and have shorter lifespans. Also, they are much more numerous than the animals that prey upon them. For instance, think of the many creatures that eat mice. Weasels, foxes, cats, owls and hawks are just some. Huge numbers of mice must be produced if the mouse species is to survive.

A rapid birth-rate is one reason small animals are successful. The common meadow mouse, for example, is the most rapidly reproducing mammal known. A pair of these mice may have ten separate families, each averaging six small mice, in a single year. During the warmer months they will produce young every three weeks—and the young ones start having their families only



Where does man fit into this pyramid?

45 days after they are born! If all these mice survived, there would be a great number around in a very short time. Can you complete the chart below to show the number of mice produced between May 1 and September 1?



How many mice could one pair of meadow mice produce from May 1 to September 1, if all lived?

In spring, it is not unusual to find one pair of meadow mice for every 3 m^2 in a hayfield. Can you imagine two mice for every 450 cm^2 of that plot in the fall? Fortunately, such things do not happen. A great many predators eat mice, and disease and parasites also help to keep mice from becoming knee-deep. Without these natural controls we would need a Pied Piper in every community! Who was the Pied Piper? Do you know any other stories of mice or rats?

Smaller mammals that provide food for others do not live very long in the wild. About 90 out of every 100 rabbits born this year will not have a first birthday. A wild two-year-old cottontail rabbit is a real "grey-beard"!

Weasel with mouse

The table below shows the average life spans for several common Canadian mammals which live in the wild. The larger mammals, and particularly those that are predators rather than prey, live much longer lives. So do some wild animals that live in captivity. Why would this be so?

Average Life Spans of Some Common Mammals

shrew	less than ½ year
meadow mouse	less than ½ year
cottontail rabbit	less than 1 year
jack rabbit	less than 1 year
coyote	about 2 years
white-tailed deer	about 3 years
black bear	4 to 6 years
polar bear	probably over 10 years
moose	4 to 5 years

What is the average lifespan of each of the following mammals: house cat, dog, horse, man? Which is the longest living mammal on earth? Are turtles mammals? Find out how long sea turtles live.

As a rule, smaller mammals have bigger families and give birth more often than the larger mammals. Compare the meadow mouse with the polar bear. The bear has cubs only about every third year, but she has few enemies and she carefully looks after her family of one, two or three.

Wear on the tooth enamel of a horse is a good indicator of the horse's age. "Never look a gift horse in the mouth" is an old expression. What does it mean?

Man as a Predator

Man has been a hunter and food gatherer for more than a million years. Many men still have a deeply rooted instinct to search and hunt in wild places for the same things their ancestors hunted. For the traditional hunter—man—the use of weapons to hunt alert, quick-moving animals is an important part of the hunting experience. The urge to use weapons skillfully is important to many boys, also, and is largely an instinctive force. Boys at play throw pebbles at various targets. List as many sports as you can that require skill in aiming something at a target.

Men and women do not seem to have the same interest in hunting wild things. Some people say this is because men have a stronger instinct to hunt. Other people say this is because boys and girls are taught to have different interests. What kind of evidence could you collect to support one of these arguments?

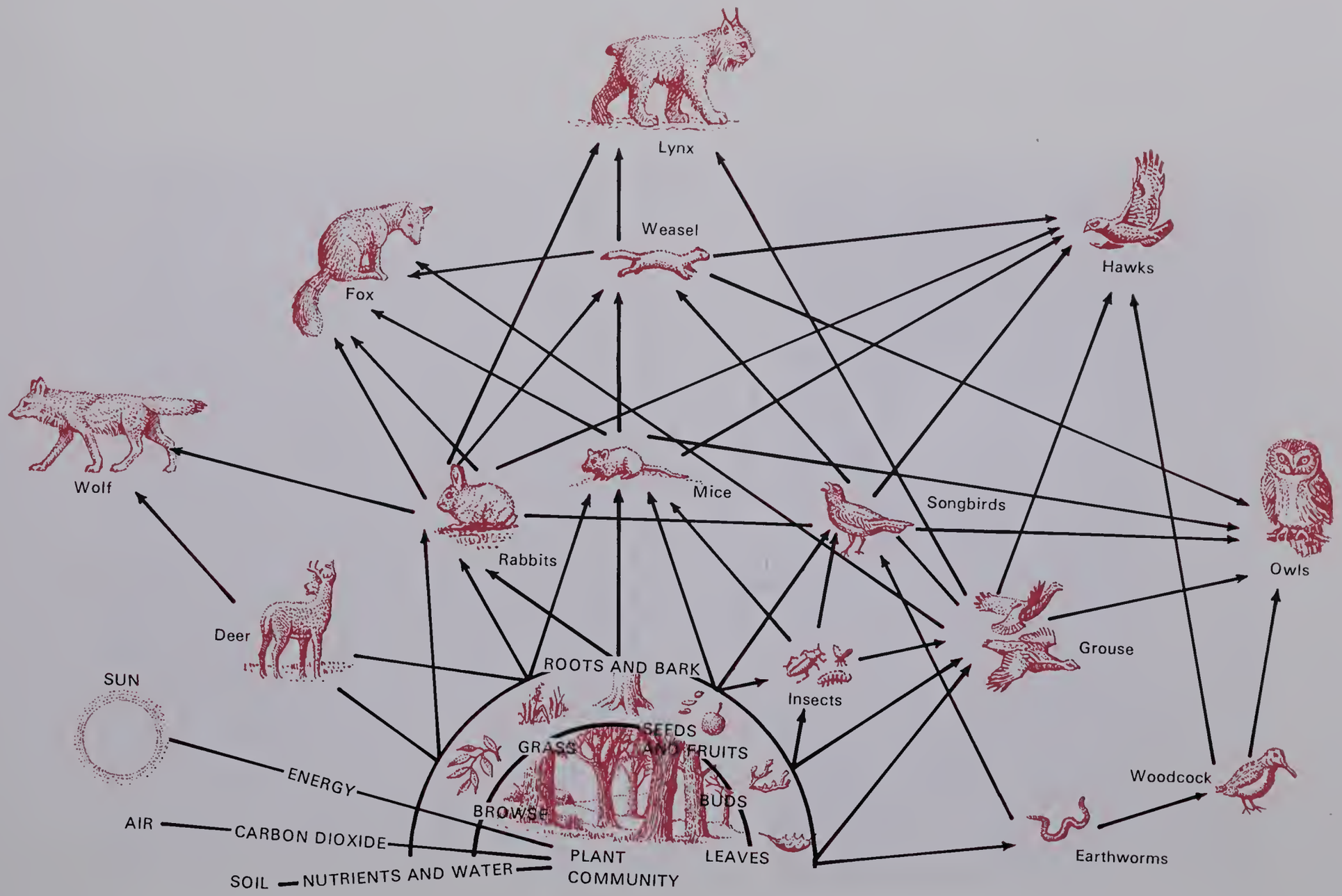
Sport hunting is misunderstood by an increasing number of people who think of wildlife "conservation" as wildlife "preservation". Some people believe that sport hunting is the cause of animals' becoming scarce, or even extinct. This is not so.

Man's carelessness and greed in pioneer times almost caused the extinction of the vast herds of buffalo on the western plains.

Nature produces animals, particularly the smaller birds and mammals, in great numbers each year; then, like annual weeds, many of them die before the next growing season. Hunters can safely take some game animals each autumn without reducing the next year's crop of game. All that is needed is a "seed stock" to refill nature's store of wildlife.

His Royal Highness Prince Philip has written about conservation and hunting in a recently published book, *Wildlife Crisis*. He says, "I am always amazed that so many townspeople seem to be incapable of understanding that hunting and conservation are entirely compatible. They simply do not wish to recognize that in most parts of the world, leadership in conservation has come from experienced hunting sportsmen."

Conservation means wise use; and people can hunt without hurting future populations of wildlife, as long as there are proper hunting regulations. Indeed, hunters have done a great deal to preserve wildlife habitat. This is most important if wildlife is to survive in good numbers.



THE WILDLIFE COMMUNITY

The Wildlife Community

The web of life is complicated, and often one creature affects the life of another in a hidden or indirect way. The chart showing some of the relationships in a forest-wildlife community looks somewhat like a spider web, even though only a few mammals are included.

So naturalists observe, a flea
Hath smaller fleas that on him prey,
And these have smaller still to bite 'em;
And so proceed, *ad infinitum*.

Jonathan Swift

Wild Predators and Man

Snowshoe hares are among the many species of small mammals taken by red foxes.

For a very long time, man has thought of many of the larger predators as his enemies. Foxes, raccoons, skunks, hawks and owls occasionally take farm poultry; coyotes and wolves sometimes take larger farm stock; and many animals take other game that man is interested in for himself.

When wild predators cause damage to livestock, the trouble often stops when we remove the guilty animals. But man does not always stop at that, since many people believe that *all* predators should be killed. When this has been tried, man often has been the loser. For instance, western sheep farmers used poison over wide areas to rid their ranches of coyotes—which resulted in plagues of mice that destroyed valuable grassland. Why did this come about?

Though many people cannot see any possible good in some predators, these animals play a very important role in the wildlife community. Over countless centuries they have caused the

An arctic wolf (circle) and barren ground caribou. Only the caribou nearest the wolf are alarmed; the others in the herd carry on normal behaviour.

wild animals which are their prey to evolve or change into strong, healthy, wary creatures, much better able to meet the hardships of life in the wild. The best animals can escape their predators, and live long enough to produce offspring that inherit their good characteristics. Thus the fittest survive, the weak do not.

The arctic wolf, which follows barren-ground caribou herds, takes the weak, crippled or aged stragglers first. Healthy caribou in the prime of their life can escape and are taken far less often.

Wildlife biologists who studied wolves and moose on Isle Royale, a large island in Lake Superior, found that a wolf pack on the island "tested" an average of twelve moose before they found one weaker than the rest.

Would the deer we know have been a different animal without the wolf? In what ways would it be different? Why are few albino animals found in the wild?

Many people fear wolves. Do you? Do your friends? Why? Perhaps it is because stories like Little Red Riding Hood have been told for centuries. Normal, healthy wolves do not bother humans. A Canadian newspaperman in a Northern Ontario town has made a long standing offer of 500 dollars to anyone who can prove that he was "et by a wolf". No one has collected!

Frequently one creature relates to another in a hidden or indirect way. Man, without a good knowledge of ecology, often upsets nature in ways he never intended.

An excellent example of this occurred in the Kaibab Plateau, which includes the north rim of the Grand Canyon in Arizona. Here there lived a thriving herd of about 4000 deer, hunted both by man and by wild predators such as cougars, wolves, coyotes and bobcats. In 1906, hunting for deer was stopped and government hunters began a program of killing off the wild predators to protect the deer. Unlike many parts of Canada, there were no harsh winters to control the deer population, and with no predators at all, the deer increased very rapidly. In a few years there were thousands of deer, and by 1924, an estimated 100 000 lived on the Kaibab range. But this was too many deer for the forest, and that winter the deer ate what was left of the twigs and other plants which made up their winter food. The countryside looked as if a swarm of locusts had swept through it; almost every low-growing twig and leaf had been stripped from trees and shrubs. Deer could not get enough to eat and they died by the thousands. The forest was damaged so seriously that for years afterward only a few thousand deer could be fed each winter. By removing natural predators, man thought he was doing the deer a favour—with disastrous results.

Man always has been careless in his treatment of other creatures. Humans have destroyed both the habitat of wild animals and the animals themselves. Only a few hundred wood bison remain in Canada. The northern kit fox of the prairies may be extinct, as may be the black-footed ferret which lives and preys upon the very few prairie dogs left in southwestern Saskatchewan. The Vancouver Island wolf is nearly extinct, and

the pine marten and arctic hare in Newfoundland are very scarce. The eastern cougar *may* be extinct; the California bighorn in southern B.C. is endangered. The sea otter was exterminated from Canadian waters on the west coast early in this century.

The Newfoundland marten is endangered. This is a western marten. Marten are very numerous in some parts of Canada.

Why should we worry if some species disappear from the earth? There are many good reasons. Wild creatures have played a very important part in our lives through the ages and will continue to do so. By thoughtlessly destroying a species, man may be throwing away the chance to make a better life for himself.

Perhaps a more important reason is that one animal affects others, and the loss of one creature upsets forever the natural community of plants and animals in which it evolved. Even man himself may be in danger of extinction, and an understanding of how natural communities live may be very important if man is to survive on this earth.

Endangered mammals in Canada

In July, 1960, about thirty sea otters from Alaska were released off the northwestern coast of Vancouver Island to try to establish this species in Canada once again.

Very small changes can sometimes upset nature with disastrous results.

"For want of a nail the shoe is lost,
For want of a shoe the horse is lost,
For want of a horse the rider is lost,
For want of a rider the battle is lost."

Geo. Herbert

Man is a very clever mammal. His inventions and machines have made his life easier and more comfortable. But man's ability to change his natural environment has caused great changes in his habitat as well.

Only recently have large numbers of people become interested in and concerned about such dangers as the widespread use of poisons such as D.D.T., and water and air pollution which are so common near centers of human population.

There is very little protective cover for mammals and birds along this fenceline.

This thick roadside cover provides a safe home for many birds and mammals.

Humans are increasing very rapidly. This concerns scientists who know from experiments that other mammals can increase in number only until food and living space are gone or until their habitat cannot absorb the waste products which pollute it. How quickly are human populations growing? In 1650 there were about 500 000 000 humans on earth. This doubled to about 1 billion people by 1850, 200 years later. In another 80 years the population doubled again, to 2 billion by 1930. The present world population is about 3½ billion people, and scientists say it will double again to 7 million in 35 years time. By then, the year 2005, will man have found ways to live without destroying his habitat?

A man visiting a zoo saw a sign over a closed door. The sign read, "The Most Destructive Animal On Earth". The visitor opened the door. What did he see?

A. His image in a mirror.

City living forces people close together.

People who love nature hate to see man destroy the habitat of wild creatures. But man seems to be destroying his own habitat as well. Think of some examples of how man has made it harder for himself

—to enjoy recreation

—to work well

—to stay healthy.

The population of North America is not nearly as large as that of Asia. Because of this, some people believe that North America easily could support a much larger human population. More people could live in North America, but perhaps then they would not be able to enjoy all the things most North Americans have become accustomed to, such as stoves, refrigerators, washers, driers, cars, television sets—the list is very long!

Each North American uses up the natural resources of his country about 30 to 50 times faster than a resident of India, for instance. The average American during his lifetime will have owned several cars and many appliances. He will have used an estimated 117 000 000 litres of fresh water and 94 500 litres of

Compare this picture with the subway scene.

Man's pollution comes in many forms.

gasoline. Steel making uses large quantities of water—about 450 000 litres to produce one automobile. Production of steel in the United States is about 50 times that of India, and the use of steel by individual North Americans is even greater. Natural resources of Canada and the United States are being used up at a much faster rate than many people realize.

India has a population of 555 millions. How does Canada's population compare with India's in terms of using natural resources if each Canadian uses 50 times the resources of an East Indian? Do you think this high use of resources might cause problems in the future? What sort of problems?

FOR FURTHER STUDY

Using classroom materials (sand tray, construction paper, etc.) make a model of the habitat of a common wild mammal in your area. Include all the things necessary for its survival.

What would happen in nature if you were to destroy one or more parts of this habitat? (You could show the "chain reaction" on your model with coloured string.)

Make a list of the ways man has changed the natural environment of your community. How has this affected the lives of wild mammals? Does this affect the way you live? How could your community improve this? How is the habitat you live in affected by people outside your community?

Questions

1. How is man polluting the air and water?
2. What is noise pollution?
3. How can you do your part to cut down pollution?
4. In your art class make posters which will help people to be aware of the hazards of pollution.
5. Through research find out what animals have become extinct and tell why this has happened.
6. In this chapter a pyramid of life was diagrammed. Make other pyramids which show how various animals and plants are dependent on one another.

References

BOOKS

Burt, W. H. and R. P. Grossenheider, *A Field Guide to the Mammals,* Houghton-Mifflin Co., Boston, 1964.

E.S.S., *Animals in the Classroom: A Guide for Teachers,* Webster Division, McGraw-Hill, New York, 1970.

Farris, Edmond J., *The Care and Breeding of Laboratory Animals*, John Wiley & Sons, New York, 1950.

Hediger, H., *Wild Animals in Captivity*, Dover Publications, New York, 1950.

Moore, Clifford B., *The Book of Wild Pets*, Charles T. Branford Co., Newton Centre, Ma., 1954.

Nuffield Junior Science Project, *Animals and Plants*, William Collins, London, 1967.

Nuffield Junior Science Project, *Mammals in Classrooms*, William Collins, London, 1967.

Peterson, R. L., *The Mammals of Eastern Canada*, Oxford University Press, New York, 1966.

Rockcastle, Verne N., *Keeping Animals in the Classroom*, Cornell Science Leaflet, vol. 53, no. 1, Ithaca, N.Y., 1959.

Vessel, M. F. and E. J. Harrington, *Common Native Animals*, Chandler Publishing Co., San Francisco, 1961.

GOVERNMENT PUBLICATIONS

Cameron, Austin W., *Canadian Mammals*, National Museum of Canada.
Available from the Queen's Printer, Daly Building, Mackenzie & Rideau Streets, Ottawa, Ontario. $1.00.

Cowan, I. M. and C. J. Guignet, *The Mammals of British Columbia*.
Available from Publications, British Columbia Provincial Museum, Victoria, B.C. $2.00.

Cummings, H. G., *The Whitetailed Deer in Ontario*.

Available from the Ontario Ministry of Natural Resources, Conservation Information Section, Queens Park, Toronto, Ontario. No charge.

Furbearers of Manitoba

Available from the Manitoba Department of Mines and Natural Resources, Conservation Extension Branch, Box 11, Building 15, 139 Tuxedo Boulevard, Winnipeg 29, Manitoba. No charge.

Upland Game Birds and Animals of Manitoba.

Available from the Manitoba Department of Mines and Natural Resources, Conservation Extension Branch, Box 11, Building 15, 139 Tuxedo Boulevard, Winnipeg 29, Manitoba. No charge.

Wolves and Coyotes in Ontario.

Available from the Ontario Ministry of Natural Resources, Conservation Information Section, Queens Park, Toronto, Ontario. No charge.

Separate leaflets on individual mammals are available from the following sources.

Canadian Wildlife Service, 400 Laurier Ave. W., Ottawa, Ontario. No charge.

Fish and Wildlife Branch, Department of Recreation and Conservation, Victoria, B.C. No charge.

Ontario Ministry of Natural Resources, Conservation Information Section, Queens Park, Toronto, Ontario. No charge.

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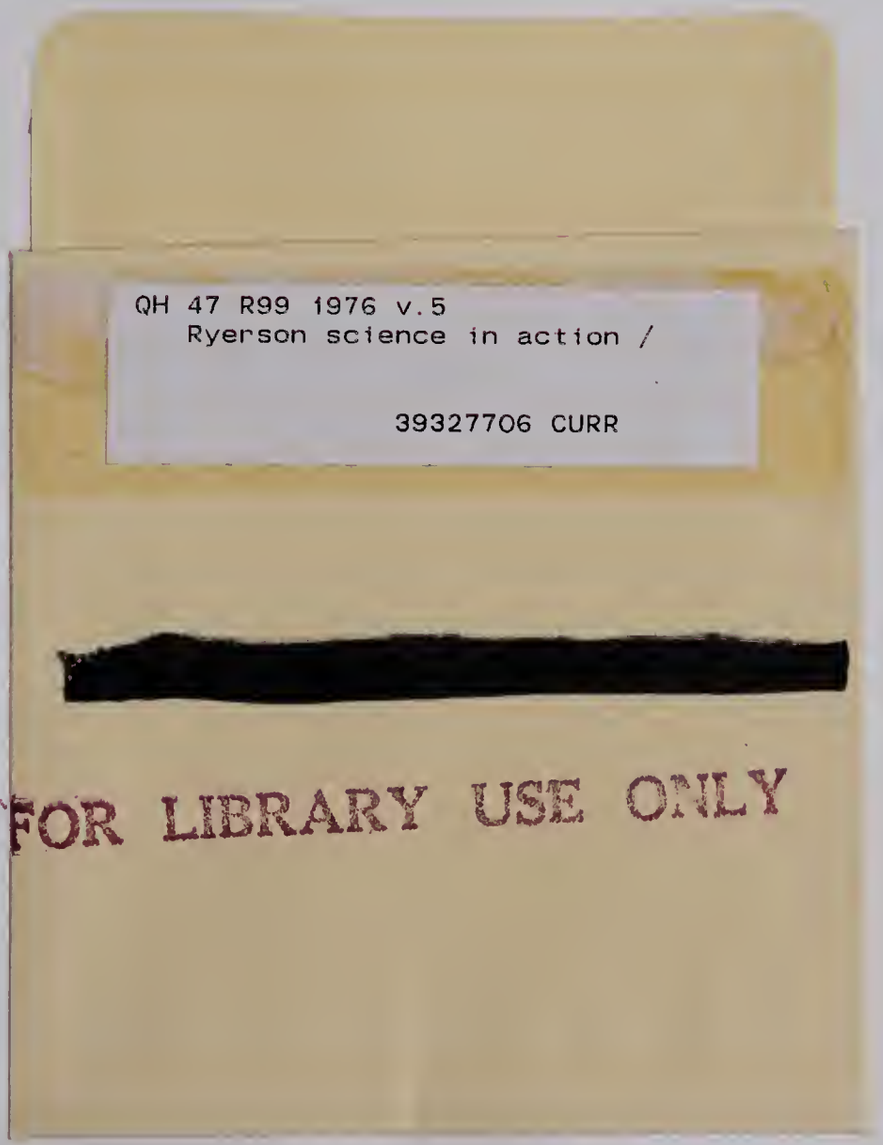

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